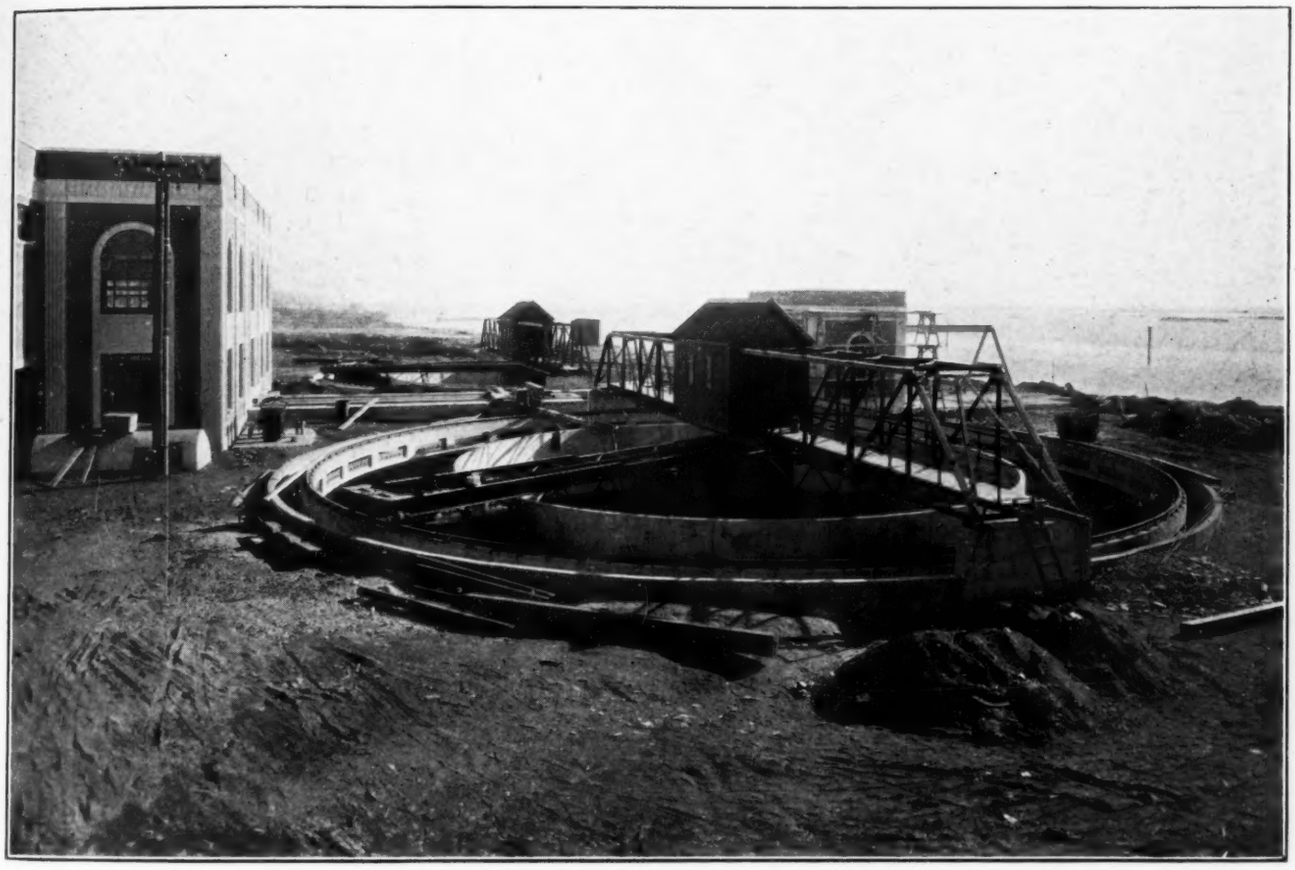
WATER WORKS AND SEWERAGE

ABC ABP

February, 1935 — L. H. Enslow, Editor — Vol. LXXXII. No. 2



The 10 M.G.D. Chemical Sewage Treatment Plant at Perth Amboy Nearing Completion. (Lewis P. Booz, Engineer.)

IN THIS ISSUE

Determination of Residual Chlorine
The Elimination of Check Valve Slam
Are Water Utilities a Good Investment?
Sewage Disposal in the United States: A General Review
Report of Convention of New York State Sewage Works Association
Chicago Combination Aerator and Clarifier: Results of Performance Tests at Monroe, Wis.

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(Recent installation of Super-de Lavaud Pipe at Asbury Park, New Jersey.)

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WATER WORKS & SEWERAGE

L. H. ENSLOW,
Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues

H. H. Hendon, in the Dec. 1933 issue of WATER WORKS AND SEWERAGE, described the design of a sewage treatment plant, then just under construction, at Birmingham, Ala., to employ chemical precipitation. In the next issue he will report on the operation of this plant during 6 months and cite costs.

G. Gale Dixon, Consulting Engineer, Youngstown, Ohio will discuss the "Hydraulics of Rapid Filters" from the standpoint of the designer and waterworks manager, who seeks to procure genuinely effective filter washing under all conditions, and at the least construction cost and operating expense. The author's experiences make possible the presentation of examples and comments of especially practical value.

W. A. Taylor, Cons. Engr., New York City, in the next issue will describe the small, novel and compact "Wastes Disposal Works of Canajoharie, N. Y."—wherein rubbish, garbage, sewage sludge, digester gas and city collected garbage and oil wastes, are burned together in a combination one-man garbage and sewage disposal plant. Initial operating results are to be appended.

W. M. Rapp, Superintendent of Construction Distribution, Atlanta, Ga., Water Department will describe an ingenuous and economical scheme and equipment used for cooling water served through drinking fountains. He puts to use at but little investment, the natural ground cooling which is responsible for the coolness of spring and well waters.

"Practices in Water Meter Replacements" as developed and applied in Los Angeles are to be disclosed by Chas. L. Ruckman, Asst. Supt., of Meter and Service Div., of the Los Angeles Water Department.

"Sewage Sludge Its Preparation and Sale" by M. W. Tatlock, Supt. of Dayton's Treatment Works, constitutes a story, relating four years of experience in marketing digested sludge as fertilizer at Dayton, Ohio. Purchasing sludge from nearby plants to make up local deficiency, in order to meet demand, is something new in sludge disposal experiences.

P. S. Wilson, Consultant in Water Works Practice, Glen Ridge, N. J., will continue with his series of articles dealing with "Hydraulics for the Practical Water Works Man." The next will reveal simple "Methods for Making Fire-Hydrant Discharge Measurements and their Application to Operating Problems."

J. E. Herring, Supt., of Meters at Jacksonville, Fla., will relate methods employed in the operation of his department, including field tests, and shop practices in maintenance, repair and testing of meters.

Dr. W. Rudolfs, Director of the N. J. Sewage Expt. Station, will report on basic studies of the mechanics of the activated sludge process and the effects that varying degrees of chlorination of sewage or sludge has on the process.

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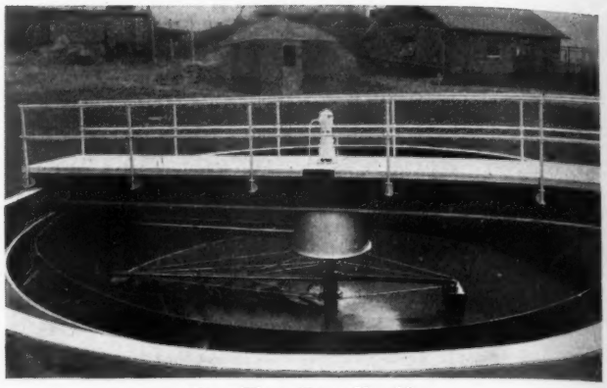
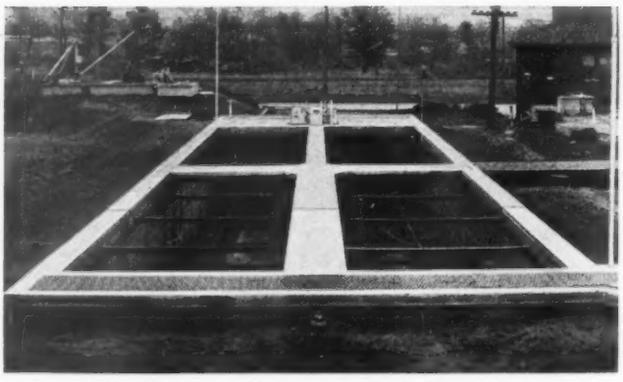
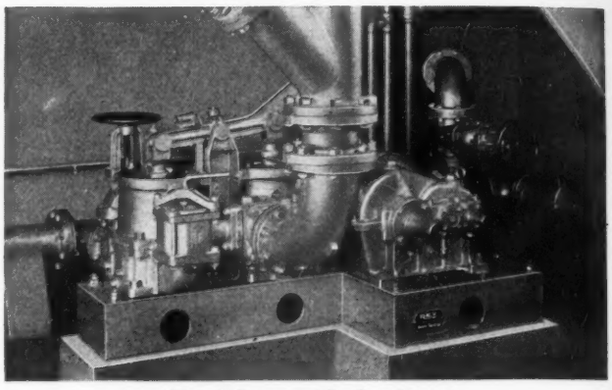


Rex Tow-Bro Clarifier



Rex Chain and Scraper Sludge Remover



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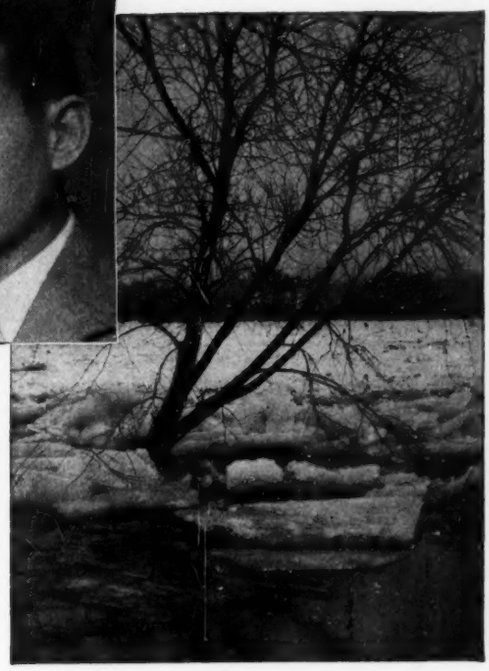
Timely TASTE *and* ODOR CONTROL *Suggestions*

By F. E. STUART



Pictures from Wide World Photos.

WINTER TIME . . . FLOOD TIME

THE following suggestions are offered by F. E. Stuart of our Water Purification Division for your guidance, because of unusual weather conditions now prevailing.

1. During serious taste and odor control difficulties such as are liable to occur from run-offs and floods, it is advisable to prechlorinate heavily and adjust the coagulant so the most effective type of floc can be formed.

2. The next step is to place all available filters in service, at the slowest practicable rate of filtration.

We Ask Your Indulgence

Because of the unexpected heavy demand for Nuchar Odor Detectors, we have been swamped and had to order more glass tubes causing a short delay. Please bear with us and feel sure your request will be filled.

3. The application of AQUA NUCHAR, activated carbon, directly to the filter influent at a dosage of 16 lbs. per million gallons, together with a duplicate dosage in the mixing chamber.

4. Individual samples should be taken from filter units to determine whether any one filter is responsible for the taste and odor produced. The Aqua Nuchar Odor Detector should be used to accurately make these determinations.

5. After filtration it is always good practice to use the ammonia-chlorine treatment, especially in connection with prechlorination.

6. As soon as the taste and odor is removed, adjustment of the carbon dosage can be made, possibly discontinuing the application of carbon to the filters because the application in the mixing chamber will keep the filters "seeded" with carbon particles. Prechlorination should be continued at a high dosage if there is possibility of contamination, because it is always better to be safe than sorry.

Mr. Stuart will consider it a privilege to answer correspondence on your taste and odor problems.

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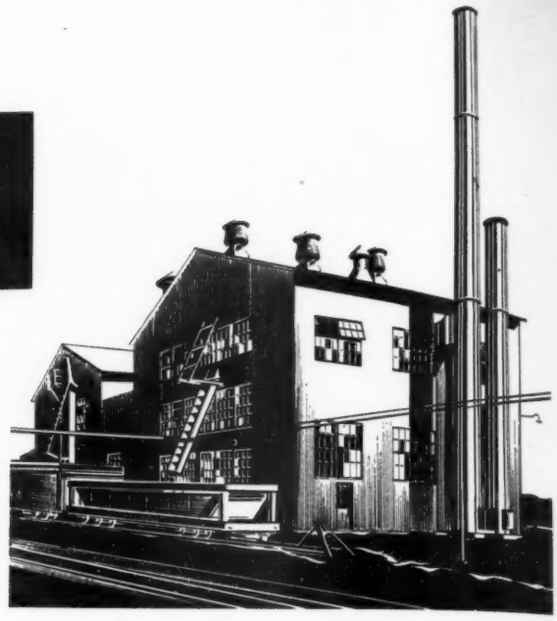

Odorless Incineration of Sewage Sludge is Guaranteed with the

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Every sanitary engineer, every public health official, every municipal and county officer concerned with the question of public sanitation realizes how vitally important this matter of odorless operation is.

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Write for copy of the C-E Raymond System of Sewage Sludge Incineration bulletin — "Incineration Ends the Sewage Problem."

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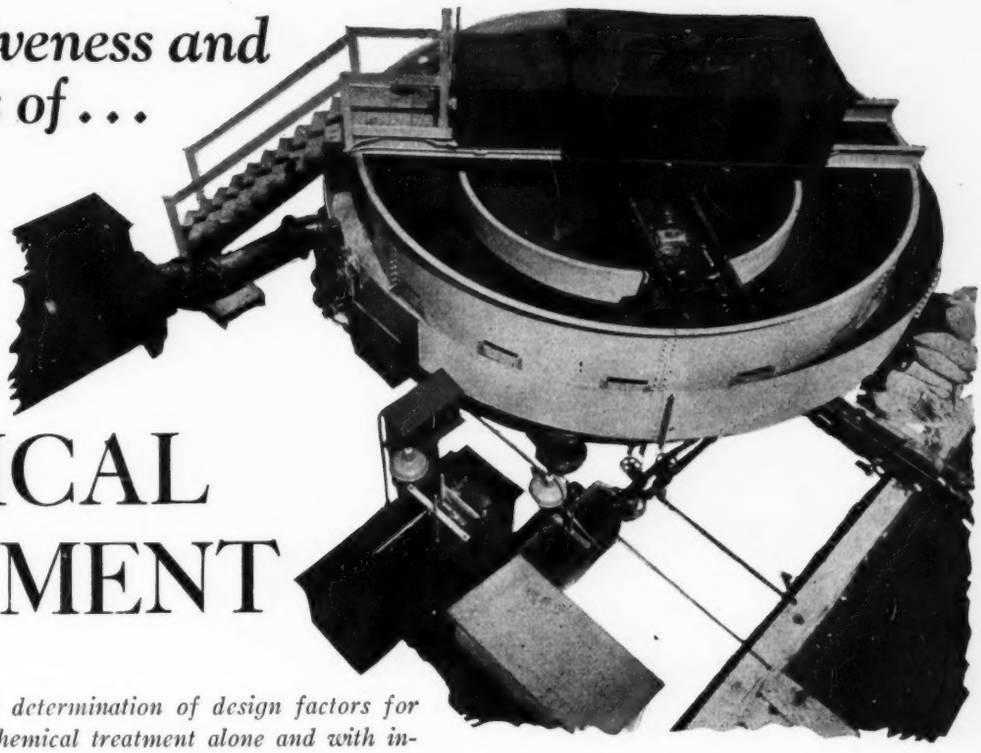

CHEMICAL TREATMENT

• **ATLANTA** *For the determination of design factors for the application of chemical treatment alone and with installed sprinkling filters, for this location, the City of Atlanta will set up and operate this twenty-foot clarifier, equipped with the Laughlin MAGNETITE Filter.*

• **CHICAGO** *Review of the figures resulting from the six months' operation of this experimental unit at the North Side Plant of the Chicago Sanitary District, will permit early publication on the efficiency of the Laughlin MAGNETITE Filter in removing solids from Activated Sludge effluents . . . in comparison with installed Sedimentation alone.*

At about the same time there will be available figures on solids removal secured from partially aerated Activated Sludge liquors.

• **NEW YORK** *The completely equipped Coney Island Testing Station continues to operate under the supervision of the Sanitation Department of the City of New York. Daily results continue to afford figures on various phases of plant design, capacities, chemicals involved, dosage, flocculation, vacuum filtration and incineration.*

• **DEARBORN** *Association with the early phases of the well-known chemical-mechanical installation at Dearborn permits continued up-to-the-minute contact with new operations there.*

All these aids to the determination of the effectiveness of comparative procedures are currently available here. Inquiry is invited from interested engineers, municipal officers and students of public economy.

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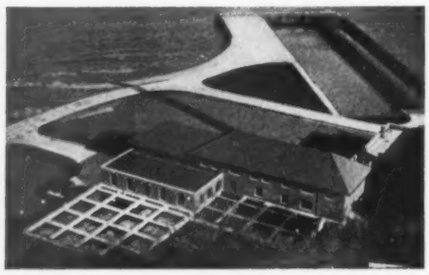

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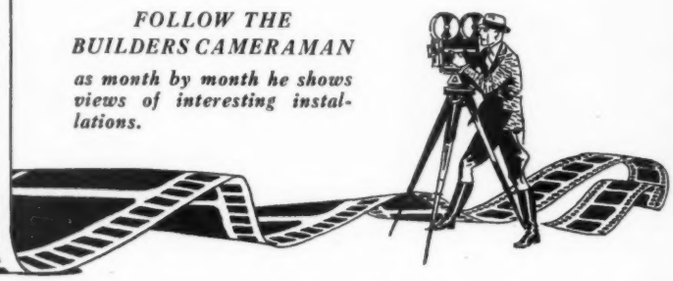

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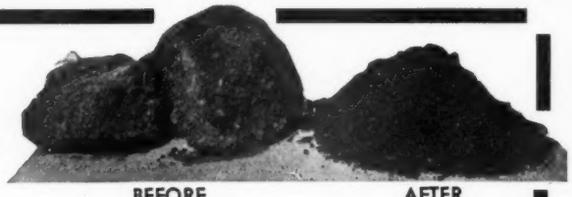
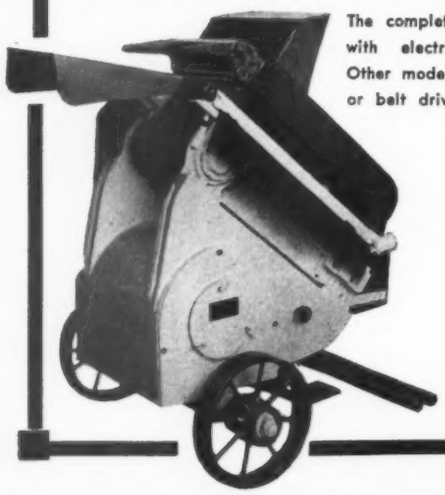


BEFORE AFTER

Showing the large damp sludge cakes reduced in one operation to a fine soil conditioner and salable product, for use on lawns and gardens.



The complete machine with electric motor. Other models gasoline or belt drive.

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An interview with James J. Buchanan, chairman, Water Commissioners, Town of Northborough, Mass.

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"Since the installation of a Chlor-O-Feeder, however, and the use of HTH in its operation, we have changed a very bad condition to one in which we now have State approval based on tests of bacteria content, color and taste. We find also that our pipe system is gradually clearing of the slime accumulation of years and we attribute this also to the use of HTH."

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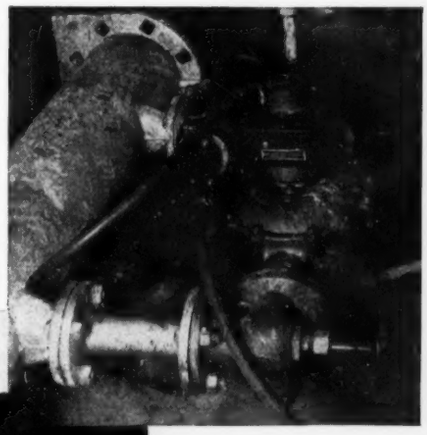

Chlor-O-Feeder installation at Northborough, Mass. feeding HTH solution in step with flow of water. The equipment is installed underground, tapped into an open main on a cement pipe 52 years old.

Reservoir supplying water to the Town of Northborough, Massachusetts.

AN ANSWER TO THE QUESTION:
"WHAT IS THE MEANING OF pH?"

pH *And Its* Practical Application

By *Frank L. LaMotte*
William R. Kenny
Allen B. Reed

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II—Hydrogen and Hydroxyl Ions
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V—Sources of Error

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XV—Cleaning Processes
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It is the purpose of this book to supply the need for such fundamental information in simple language, avoiding technical terms as much as possible.

Scientific men whose early training has not included this phase of chemistry and operating men will find "pH And Its Practical Application" to be a *practical* book for any reader who is not particularly interested in the theoretical aspects of hydrogen in concentration.

The broad scope of the book is indicated by the Table of Contents.

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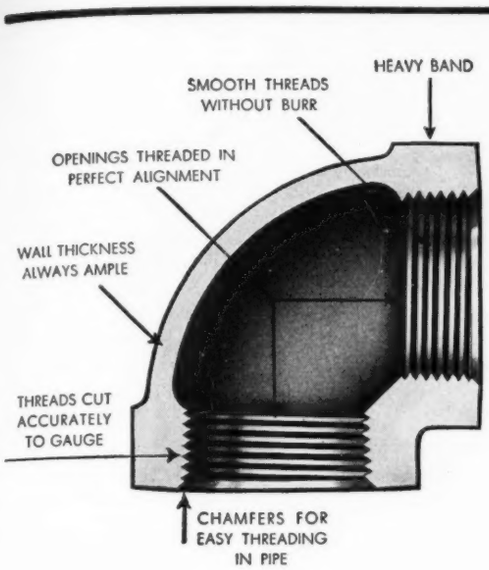
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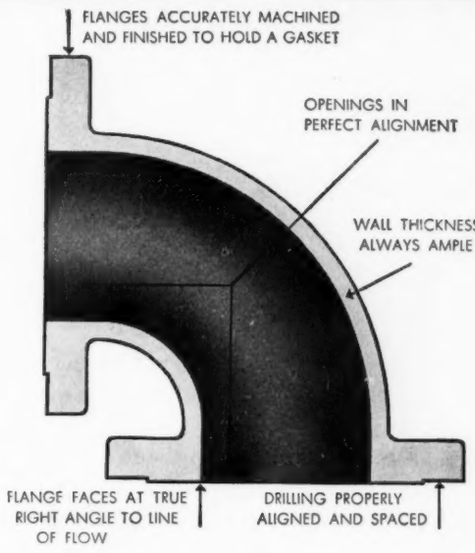
FLANGES ACCURATELY MACHINED AND FINISHED TO HOLD A GASKET
OPENINGS IN PERFECT ALIGNMENT
WALL THICKNESS ALWAYS AMPLE
FLANGE FACES AT TRUE RIGHT ANGLE TO LINE OF FLOW
DRILLING PROPERLY ALIGNED AND SPACED

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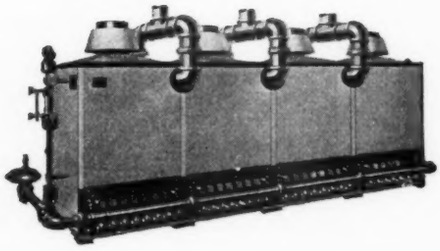

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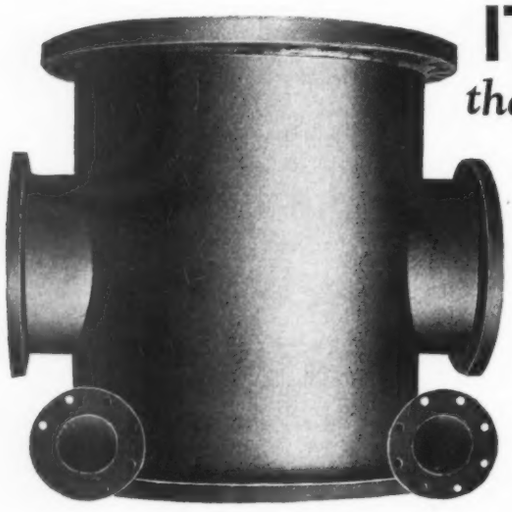

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"LYNCHBURG" has built its enviable reputation on its ability to produce difficult "SPECIAL" fittings and big cast iron pipe of the finest quality—work that demands the best Foundry Technique . . . Special equipment, and an organization trained to the job enable us to boast that a job does not come too large or difficult for us to handle with dispatch . . . Write, Wire or Phone "Lynchburg" for quick estimates.

Bell and Spigot Pipe and Fittings. From 4" to 54".
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Yes—we would like you to mention WATER WORKS AND SEWERAGE.

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The following cities have adopted Ferric Chloride as their sludge conditioning agent:

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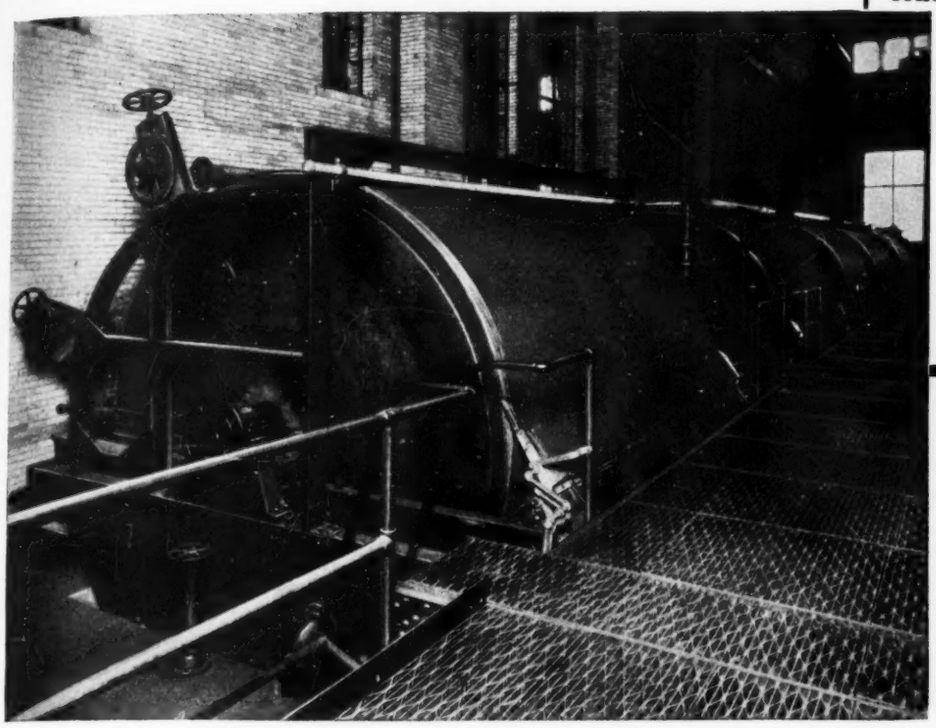
CHICAGO, ILLINOIS
(*West side experimental plant*)
COLUMBUS, OHIO
SPRINGFIELD, OHIO
ANNAPOLIS, MD.
HAGERSTOWN, MD.
HIGH POINT, N. C.
GASTONIA, N. C.
CHARLOTTE, N. C.



Photograph courtesy of Milwaukee Sewerage Commission. . . . First plant to use Ferric Chloride in sludge dewatering.

THE use of Ferric Chloride as a sludge conditioning agent is rapidly growing in popularity. It has been proven to be the most effective conditioner for activated sludge prior to vacuum filtration.

The Pennsylvania Salt Manufacturing Company was the first company to produce Ferric Chloride in a form suitable for use in sewage disposal plants at a cost within the range of economical sludge disposal operations.

LIQUID FERRIC CHLORIDE was developed first. Today large plants with railroad sidings find it economical and practical to buy it in this form... because it is shipped direct in rubber lined tank cars.

Sewage plants without railroad sidings are now using Ferric Chloride in Anhydrous form... another development made possible by the Pennsylvania Salt Manufacturing Company.

ANHYDROUS FERRIC CHLORIDE comes in powder form. It is packed in airtight, non-returnable steel drums... Is instantly soluble... And can be stored indefinitely without deterioration or liquification.

Our specialized technical service is available without cost to adapt our products to customers' requirements.

WRITE TODAY *for Free Booklet on the application of Ferric Chloride . . . How and where to use it.*

Est. 1850 PENNSYLVANIA SALT MFG. CO.

EXECUTIVE OFFICES, WIDENER BLDG., PHILADELPHIA, PA.
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Do you mention WATER WORKS AND SEWERAGE? Please do.

60% Increase In Advertising Pages In 1934

NOTHING really happens by chance—there's always a reason. The reason why WATER WORKS AND SEWERAGE shows a 60 per cent increase in advertising volume and 83 per cent increase in number of advertisers for 1934 over 1933 is easily deducted from hundreds of letters that accompany payments for renewal subscriptions.

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Watch Water Works and Sewerage in 1935

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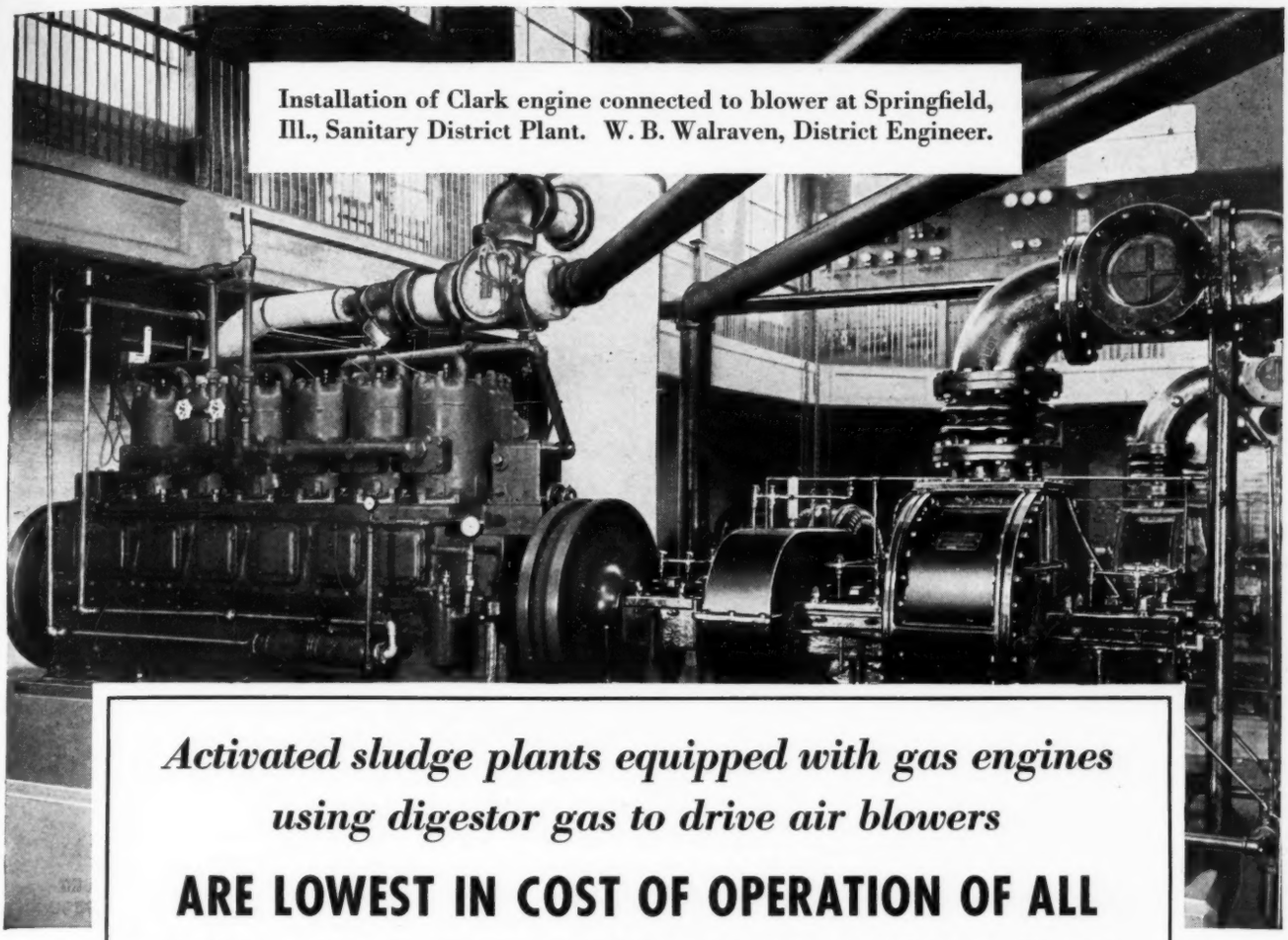

Installation of Clark engine connected to blower at Springfield, Ill., Sanitary District Plant. W. B. Walraven, District Engineer.

Activated sludge plants equipped with gas engines using digestor gas to drive air blowers

ARE LOWEST IN COST OF OPERATION OF ALL TYPES OF COMPLETE TREATMENT INSTALLATIONS

THIS fact is well proved by the successful examples of such typical equipment at Gastonia, N. C.; Charlotte, N. C.; Birmingham, England; Springfield, Ill.; Newark, N. Y., and elsewhere. News comes of additional similar plants under construction, and of existing activated sludge plants where gas engine installations are being designed.

While utilization of gas for power is adaptable to economical operation of any type plant, it is particularly effective in activated sludge plants employing the air diffusion method. This is because the energy is more efficiently utilized by the direct connection between gas engines and air blowers. Another important reason is that with activated sludge treatment, more sludge can be used for the production of gas than with other methods. The total gas production converted to power will normally exceed air blower requirements.

At the Springfield, Illinois plant, for example, one gas engine has supplied 92% of the total air requirements during the past year. Enough additional gas is available to operate another engine now being installed.

The soundness of this development is unquestioned. It has a popular economic appeal that is an invaluable talking point in the promotion of any sewage disposal project.

Consider its adoption for existing plants or for those under design. And then carry out a complete plan of real efficiency by installing Aloxite Brand Diffusers.

ALOXITE
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BRAND
DIFFUSERS

THE CARBORUNDUM COMPANY

NIAGARA FALLS, N. Y. CANADIAN CARBORUNDUM CO., LTD., NIAGARA FALLS, ONT.

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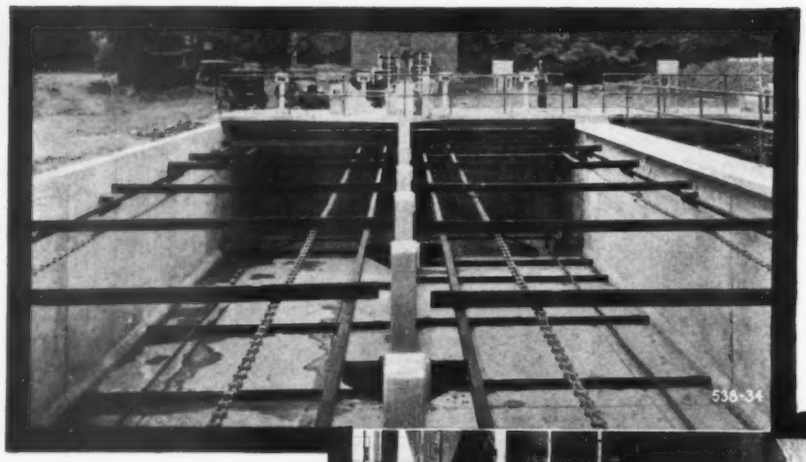
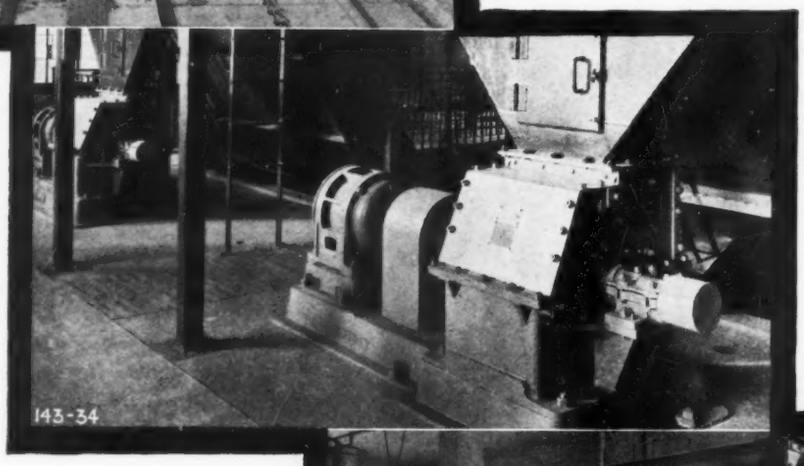


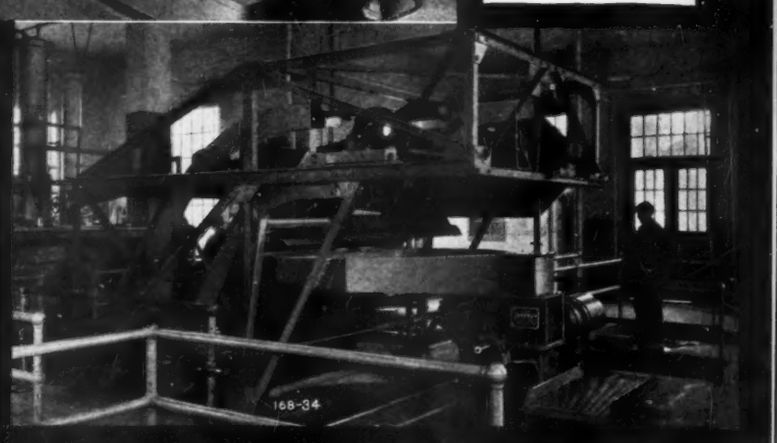
Jeffrey Conveyor-type Sludge Collectors

Designed especially for the removal of sewage sludge from rectangular sedimentation tanks. Cypress scrapers are attached to heavy Supermal Chains. Scrapers sweep tank bottom completely, and may be arranged to act as skimmers on return strand. Large carrying capacity permits intermittent operation. Under ordinary conditions a half revolution once or twice daily will remove all settled sludge. This saves power, and relieves tanks of mechanical agitation 23 to 24 hours of the day.



Jeffrey Screenings Grinders

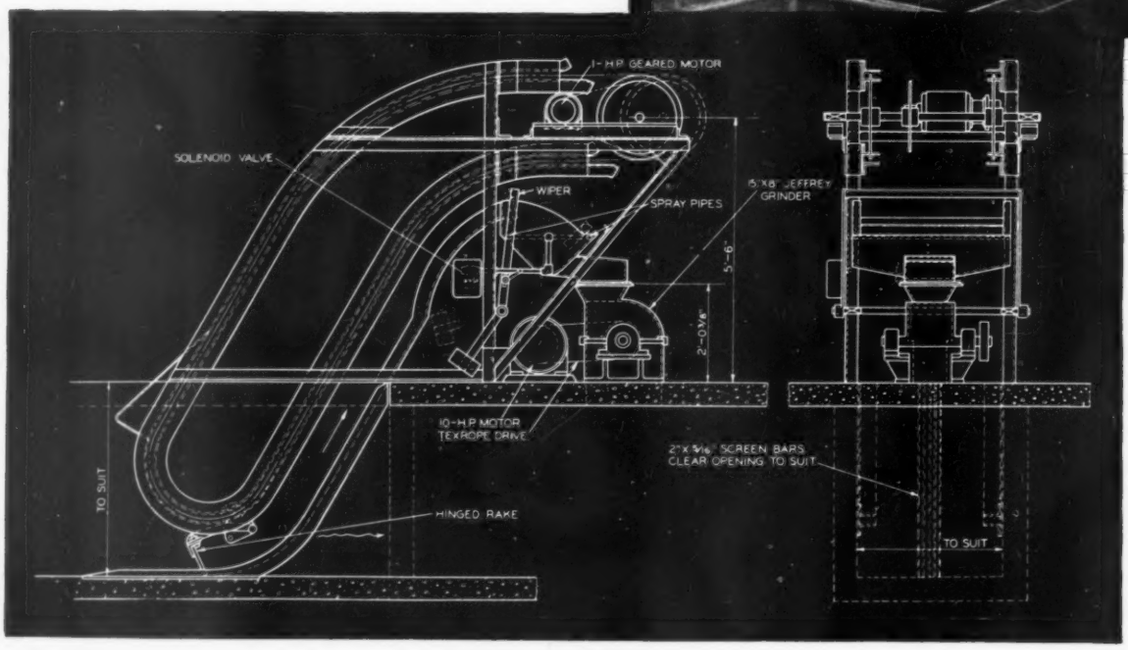
Illustration (right) shows two Jeffrey Screenings Grinders recently installed in a large Municipal Plant. The Jeffrey Grinder acually reduces the screenings to a pulp which readily passes through the pumps and sinks into the settling tanks. This Grinder does not tear the screenings into long strings or strips that will eventually clog the pumps.



Jeffrey Screen and Grinder

Illustration (right) shows a Jeffrey installation of a Self-Cleaning Bar Screen and Screenings Grinder. The Jeffrey Bar Screen has a clear opening from side to side . . . no obstructing cross members. Rake or scraper starts back of base . . . combs entirely through screen bars, cleaning not only surface but spaces between bars. Pulls hard obstructions out . . . instead of forcing them through. Automatic wiper at top removes material adhering to scraper. Screen may be hand raked if power interruption should occur. May be operated continuously or at intervals of 30 seconds to 1 hour.

The drawing (below) clearly shows the arrangement of the Jeffrey combination —Screen and Grinder. This method has proved the only way of adequately disposing of Sewage Screenings. It is simple, yet effective and you can absolutely rely upon this combination to do the job right.



Jeffrey Sewage Disposal Equipment:

Bar Screens
Sludge Collectors
Grit Channel Conveyors
Screenings Grinders
Dried Sludge Grinders

Jeffrey Garbage Disposal Equipment:

Conveyors & Elevators
Green Garbage Grinders
Shredders for Refuse & Paper
Coal & Ash Handling Equipment
Coal Crushers

(Patent Pending)

A Big Step Ahead

with

MECHANICAL HANDLING

for

SEWAGE DISPOSAL PLANTS

SCIENTIFIC, sanitary sewage disposal has expanded enormously in the past two decades, bringing with it acute problems of material handling.

Huge plants, capable of treating millions of gallons per day cannot handle materials by older, and often, obsolete, methods . . . must have mechanical handling that is not only modern, but thoroughly suited to the peculiar requirements.

Jeffrey brought to these problems an experience of over a half century in design and manufacture of material handling machinery of all types. The result is a line of Sewage Disposal Machinery that will give long, satisfactory, trouble-free service.

Our department devoted to Sewage Disposal is well equipped to offer technical information on plant design. You can rely on recommendations by Jeffrey Sanitary Engineers . . . they know your problems . . . they build for you.

Complete information on request.

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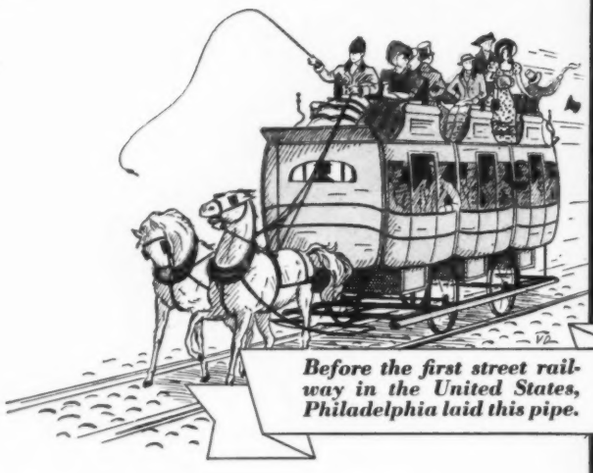
JEFFREY

MATERIAL HANDLING EQUIPMENT

After 105 years

this pipe was uncovered, inspected and okayed.



Before the first street railway in the United States, Philadelphia laid this pipe.

AT AN official inspection of the cast iron main shown at right, former Mayor Mackey of Philadelphia said over the radio: "Notwithstanding the great changes that have taken place in our city, this cast iron pipe stands perfect in all its integrity as disclosed to us tonight after having made the excavation and taken out a section." Now 105 years old, this line of cast iron pipe is good for many more years of service.

Cast iron pipe with bell-and-spigot joints offers a combination of pipe material and design that is time-tested and proved by mains still in use after serving 100 to 200 years and longer.

The four major economies resulting from the long life of cast iron pipe are due to its effective resistance to rust. Cast iron is the one ferrous metal for water and gas mains, and for sewer construction, that will not disintegrate from rust. This characteristic makes cast iron pipe the most practicable for underground mains since rust will not destroy it.

The 4 *Economies of* Cast Iron Pipe

1. Official records of cast iron pipe laid 100 to 200 years ago and still in service, prove that it is *cheapest in the end.*

2. Official reports on file in the office of a prominent technical publication, prove that cast iron pipe is *cheapest to maintain.*

3. Long-lived pipe obviously causes less street-opening for replacements and repairs. Therefore, cast iron pipe *saves money on street-openings.*

4. When replaced by larger pipe, or a main is abandoned or rerouted, cast iron pipe *pays a final dividend in salvage value.*

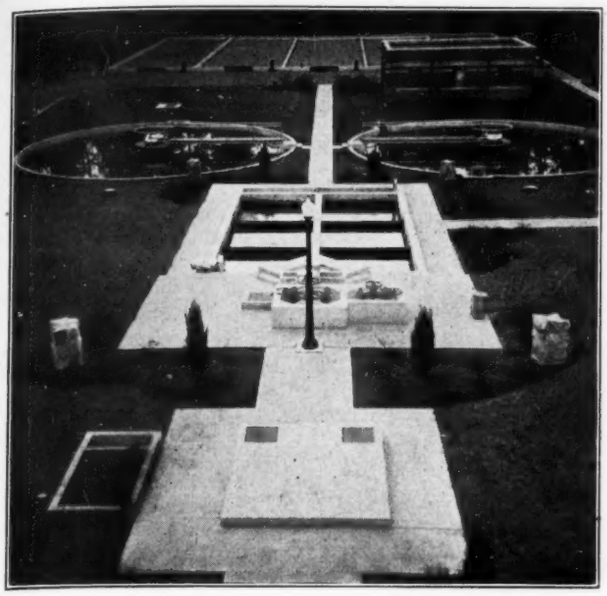
For further information, address The Cast Iron Pipe Research Association, Thomas F. Wolfe, Research Engineer, 309 Peoples Gas Building, Chicago, Ill.

CAST IRON PIPE

METHODS OF EVALUATING BIDS NOW IN USE BY ENGINEERS — RATE THE USEFUL LIFE OF CAST IRON PIPE AT 100 YEARS

TRADEMARK REG.

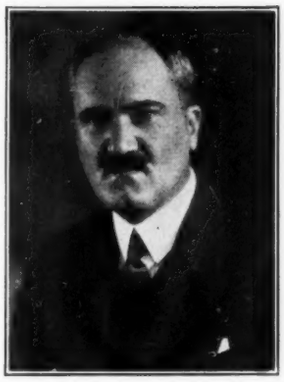
WATER WORKS AND SEWERAGE
A GILLETTE PUBLICATION
VOL. LXXXII FEBRUARY, 1935 NO. 2



The Shades Valley Plant at Birmingham, Ala. Built in 1934. Utilizes Chemical Treatment.

SEWAGE DISPOSAL IN THE UNITED STATES: A GENERAL REVIEW

By LANGDON PEARSE*
Chicago, Ill.



Langdon Pearse

AT the end of 1934, a general review of sewage disposal practice in the United States seems timely, in running comment, rather than detailed technical discussion of the events peculiar to the year just passed. Such comment is intended as a summary, rough and ready, covering the high spots. Considering the varied activities in the sewage field, a choice of topics and illustrations has been difficult. In general, progress continues in the field of research as well as in design. Forms of treatment have been appraised with regard to their peculiar fitness for various projects of large magnitude. And, of marked importance, has been the stimulus of Federal aid by making possible the financing of many worthwhile projects.

P.W.A. Stimulus

The greatest stimulus to sewerage construction during 1934 has been the activity of the Federal Emergency Administration. For its use, Congress authorized an original appropriation in June, 1933, of $3,300,000,000 for public works and a second appropriation of $400,000,000 in June, 1934. Up to November 1, 1934, a total of $798,985,383 had been allotted in loans and grants for more than 4,000 non-Federal municipal projects. Of this total, the distribution of allotments for sewers and sewage treatment are shown in Table 1.

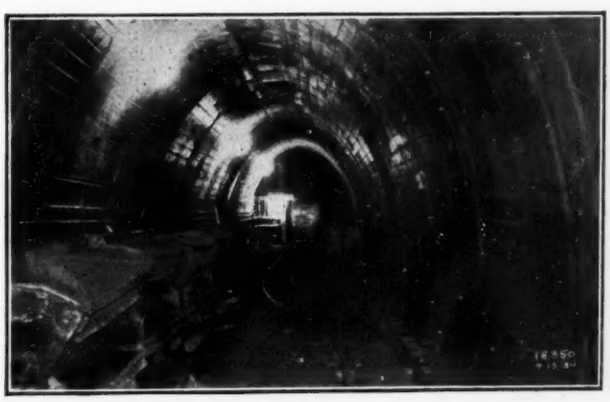
*Sanitary Engineer, The Sanitary District of Chicago.

allotted up to November 1st. Of this only $1,448,595 was allotted as a grant, as compared with $50,558,810 For sewage treatment projects, $52,007,405 had been as a combined loan and grant. For sewers, $147,875,561 had been allotted, making the total just short of $200,000,000—amounting to 25 per cent of the grants and loan total allotted for municipal public works projects.

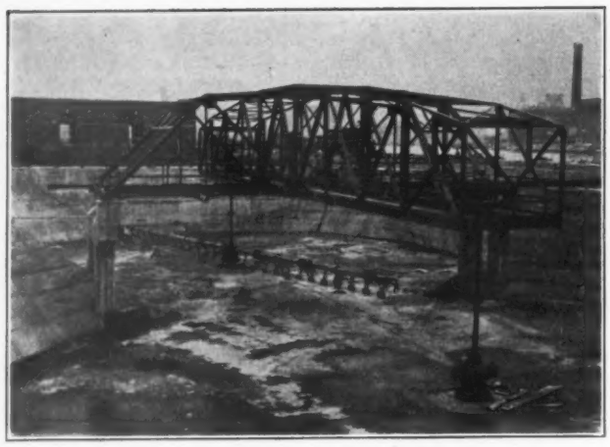
Among the larger allotments may be mentioned those listed in Table 2. During the year 1935, much larger expenditures will be made on many projects than in 1934 and continued activity may be expected in the construction of sewers and sewage treatment works. Brief comment is made on a few of the larger situations.

The Sanitary District of Chicago

The Sanitary District of Chicago is proceeding diligently with the sewage treatment construction program



West Side Intercepting Sewer No. 5, Chicago Sanitary District District.



Milwaukee Sewage Treatment Plant—Extensions. One of the Sedimentation Tanks with Tow-Brow Equipment Being Placed.

under the decree of the U. S. Supreme Court. In 1934, approximately $8,000,000 of new work was completed and upwards of 10,000 men given gainful employment. In 1935, work is expected to be accomplished under contract totaling approximately $20,000,000. This will complete the West Side Intercepting Sewer, West Side Sewage Treatment Works (sedimentation only) and the Calumet Sewage Treatment Works Extension (Activated Sludge). The new work to be undertaken in 1935 comprises the Southwest Intercepting Sewer and the Southwest Sewage Treatment Works (Activated Sludge).

New York City

The general plans for the city of New York call ultimately for the construction of some 38 treatment works.

TABLE 3—SEWAGE TREATMENT WORKS IN CITIES OVER 2,500 IN UNITED STATES
(Distribution by Types of Treatment in 1934)

Type of Treatment	In Operation	Under Construction	Proposed or Under Design
Fine screens	20	..	..
Sedimentation	36	..	5
Sedimentation and separate digestion	84	12	24
Septic tank	252	..	..
Imhoff tank	245	4	5
Direct oxidation	1	..	..
Chemical precipitation	4	1	5
Contact beds	55	..	..
Intermittent sand filters	144	..	1
Trickling filters	318	15	53
Activated sludge	69	10	31
Totals	1,228	42	124

At present, the city is building an activated sludge plant on Wards Island with a nominal capacity of 180 m.g.d. The construction on this plant began in 1931 and up to date some $5,500,000 has been spent, on plant design and construction and intercepting sewer design. No construction work has been carried on at Wards Island for over one and one-half years, because of the financial situation. An allotment of PWA funds has been secured for the construction in 1935 of the Coney Island Sewage Treatment Works—(see Chemical Precipitation).

Milwaukee

The added capacity of the new aeration and sedimentation tanks (70 m.g.d.) brings the total capacity of the Milwaukee activated sludge plant up to 155 m.g.d. for an estimated population of 980,000. From this is expected an average of 1 ton of Milorganite fertilizer per million gallons. The total cost of the plant extension is

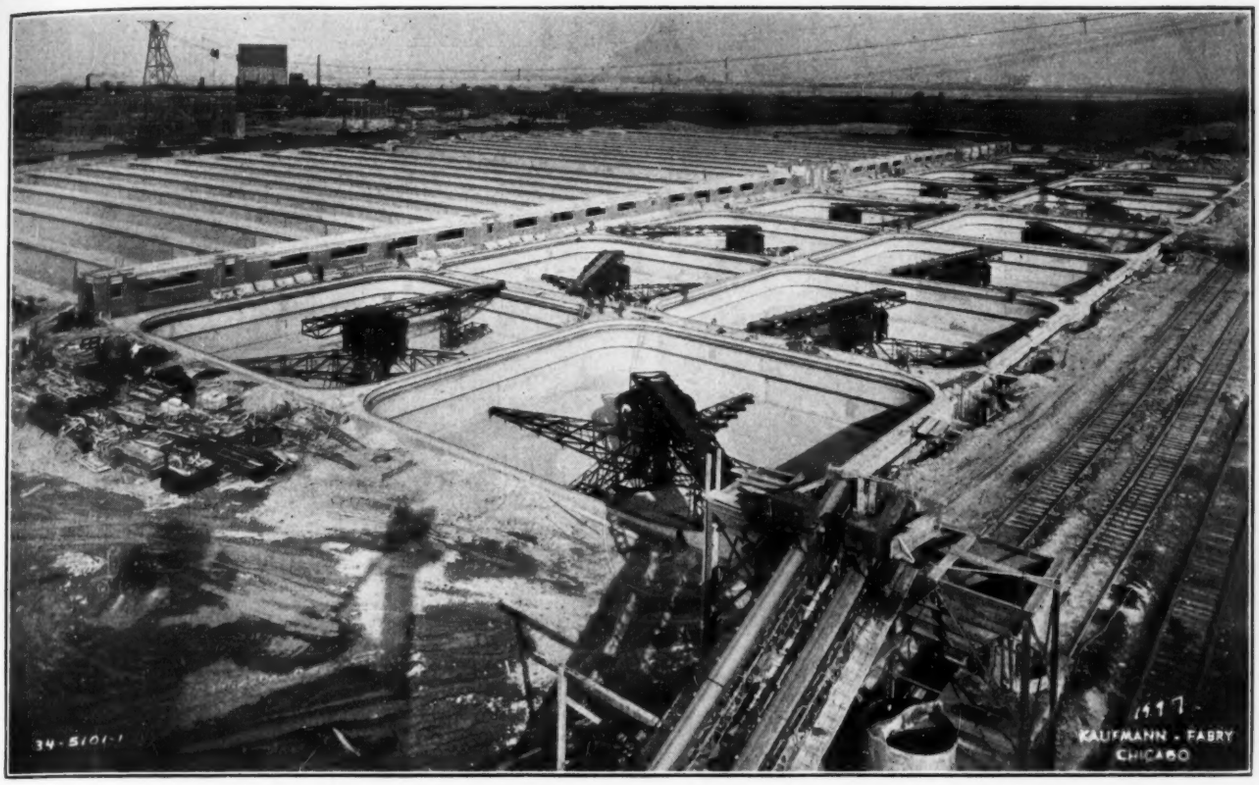
TABLE 1.—PUBLIC WORKS ADMINISTRATION ALLOTMENTS FOR MUNICIPAL WORKS, SEWERS, SEWAGE TREATMENT AND TOTALS—PRIOR TO NOVEMBER 1, 1934

	Number of Allotments			Amount		
Allotment	Sewers	Sewage Treatment	Total	Sewers	Sewage Treatment	Total
Completed	59	20	453	$930,783	$288,115	$70,371,173
Under construction	173	50	1478	82,975,858	34,554,640	442,498,996
Under contract	24	3	183	33,151,000	384,000	14,198,700
Advertised	35	3	307	1,819,300	155,000	29,814,680
Ready for advertising	85	27	761	14,604,220	3,598,000	145,243,439
Various other stages	74	35	827	14,394,400	13,017,650	160,192,395
Total	450	138	4009	$147,875,561	$52,007,405	$798,985,383

TABLE 2.—ALLOTMENTS TO CITIES FOR SEWERS AND SEWAGE TREATMENT—PRIOR TO NOVEMBER 1, 1934

Municipality	Sewers	Sewage Treatment	Combined
Sanitary Dist. of Chicago	$20,585,540	$21,352,460	$42,131,040
Minneapolis	.....	.....	10,425,000
Columbus	9,426,000	.....	.....
Cleveland	8,990,000	.....	.....
Dist. of Columbia	.....	8,000,000	.....
St. Paul	.....	.....	5,634,000
Buffalo	3,159,370	.....	.....
San Francisco	2,625,000	.....	.....
Arlington Co., Va	2,500,000	.....	.....
Portland, Ore.	2,240,000	.....	.....
Westchester Co., N. Y.	2,085,000	.....	.....
New York City	.....	1,868,000	.....
Milwaukee	.....	1,850,000	.....
Evansville, Ind.	1,172,000	.....	.....
Springfield, Ohio	.....	.....	.....
Muncie, Ind.	1,069,000	.....	.....
Peoria	1,022,000	.....	.....
Wheeling, W. Va	987,000	.....	.....
Perth Amboy	.....	859,000	.....
Jackson, Mich.	842,000	.....	.....
Green Bay, Wis	856,000	.....	.....
Hartford Co., Conn	800,000	.....	.....

Easterly Plant, Cleveland, Ohio. (George B. Gascoigne, Engineers.)



The Calumet Plant. Chicago Sanitary District.

$3,500,000. The addition is expected to be in operation early in 1935.

Minneapolis-St. Paul

Under the PWA allotment, construction is proceeding rapidly on the intercepting sewer program. The Engineering Commission (PWA) has recently brought in a report on treatment.

Cleveland

The Cleveland sewage disposal program has been divided into two parts: $12,000,000 for the Easterly plant (activated sludge), and $2,000,000 for betterments at the Westerly plant. As of January 1, 1935, at the Easterly plant work has been completed or put under contract to the amount of $6,000,000, and at the Westerly plant about $425,000. The Easterly plant is about 50 per cent completed and the Westerly about 30 per cent.

Number and Type of Sewage Treatment Works in Use

According to the 1930 census, there were 3,165 incorporated cities in the United States with 2,500 population or over. The distribution by types of treatment among these cities in 1934 is shown approximately in Table 3. This indicates 1,228 cities with plants in operation; 42 with plants under construction and 122 known to be under design, or proposed.

Types of Plants in Common Use

Today there are many types of plants or processes in common use for sewage treatment which have weathered the test of 20 years and still give service, when correctly applied and properly operated. Such may be classed as screening (coarse and fine), sedimentation, the application of chemicals (whether for precipitation, for disinfection or both), and biological treatment (intermittent sand filters, contact beds, trickling filters and activated sludge).

Present Status

With these ranges of devices and processes to choose from, what is the prevailing practice today? In other words, to what extent are the various procedures in use in the United States? A recent survey of the treatment works operating, under construction and projected in the United States, so far as they could be readily ascertained (see Table 3), sheds considerable light on the distribution of the types of treatment.

During 1934 the trickling filter was still serving the largest population. The activated sludge process handled about two-thirds the population served by the trickling filter.

Notable in this survey is the extent to which the activated sludge process has been developed and the large projects to which it has been applied. When all the activated sludge plants projected, in operation and under construction are summed up, the total population served exceeds that of any other process. This is a tribute to the courage and ability of the American engineers, designing and operating, who have developed a simple idea into real engineering structures, complete and economical. It is perhaps fair to say, despite the claims of the early British workers, that without this development the activated sludge process might have languished. The largest activated sludge plants in the world are, in fact, to be found among the larger cities of the United States.

A study of the application of various methods by five-year periods since 1891 shows that the use of the septic tank and intermittent sand filters has persisted, but only in small situations. The trickling filter enjoyed considerable growth from 1905 to 1915, and again in 1926 to 1930. Imhoff tank population reached its greatest rate of growth from 1926 to 1930, but separate sludge digestion has been attaining increased importance since 1926.

The First Unit of the New Sewage Treatment Works of Duluth, Minn., Sedimentation, Separate Digestion, Chlorination—All Units Being Housed Because of Climate (Alvord, Burdick & Howson, Engineers)

The activated sludge growth was marked from 1921 to 1925, with large increments since.

During 1934, there was more capacity under construction or contemplated for the activated sludge process than for any other. Imhoff tanks to serve nearly 500,000 population were under construction, and planned for additional population. Separate digestion plants were also built and planned, but for a somewhat less population. Several projects were started in 1934 on chemical precipitation on a throughout-the-year basis, but the greater interest in chemical treatment seems to have shifted (as measured by population) to seasonal application.

Sewage Treatment a Two-Sided Problem—Liquids and Solids

Recognition of the two distinct phases of the sewage problem has been more clearly emphasized of late, viz.: the treatment of the liquid with regard to the point for disposal and the handling of the solids retained. However, this appears to be news to many laymen, who still retain some of the old septic tank illusions and believe all solids in sewage subject to destruction by digestion.

Today, the sanitary engineer can, with greater facilities than ever before, weigh the degree of treatment required in the problems which confront him, keeping in mind the conditions which he is studying and the standards of lake, stream or waterway control to be attained. The degree of treatment obtainable is now measured largely by the yardstick of the B.O.D. test, and the removal of suspended solids. By a study of the oxygen balance attained by the treatment proposed and its relation to the stream flow or waterway conditions and the phenomena of self-purification in the waterway, a fair degree of appraisal may be made of the results expected. The methods of stream purification analysis laid down by the Eddy Committee (Engineering Board of Review, 1925), Hoskins and Streeter (U. S. Public Health Service), and, more recently, in 1934, by Childs (Minneapolis-St. Paul) serve as valuable guides.

Solids the Real Problem

The handling of the solids obtained from sewage still offers opportunity for additional research. In problems of the magnitude of those confronting The Sanitary District of Chicago (where ultimately an average of approximately 600 or 700 tons of dry solids per 24 hours may require handling), research and tests have extended over a period of several years, in which mechanical engineers and chemists have collaborated.

Advances have been made in the dewatering of solids by mechanical means—by a better knowledge of the value of pH control, the applicability of conditioners like ferric chloride and lime, and the control of the procedure by automatic devices such as the electric eye. Various appliances have been tested by the Sanitary District of Chicago, Baltimore, Hagerstown, and others on a considerable scale, including vacuum filters, bag filters, and a combination of filtration through a traveling mesh passing over vacuum boxes, followed by passing between traveling belts squeezed by rollers.

Perhaps even more important is the application of the principles of combustion engineering in the handling of sludge, and the development of apparatus particularly suited for sludge drying and incineration. In this research, The Sanitary District of Chicago stepped up its development to a working scale, by the construction, first, of a 24-ton dry solid dewatering and incineration plant at the West Side; and, later, by a 20-ton plant, which is now modified into a third phase. This is to be followed by a 40-ton plant at the Calumet Works, before undertaking the design of the ultimate plant.

Combustion of the dried sludge fed into the fire box in pulverized form (with auxiliary but separate feeding of pulverized fuel when required) has proved best adapted to the problems of sludge disposal in connection with the works of The Sanitary District of Chicago. In this connection, the value of heat as an odor destructor has been tested and proven in the Sanitary District developments, wherein all gases are heated to a temperature of over 1,400 deg. Fahr.

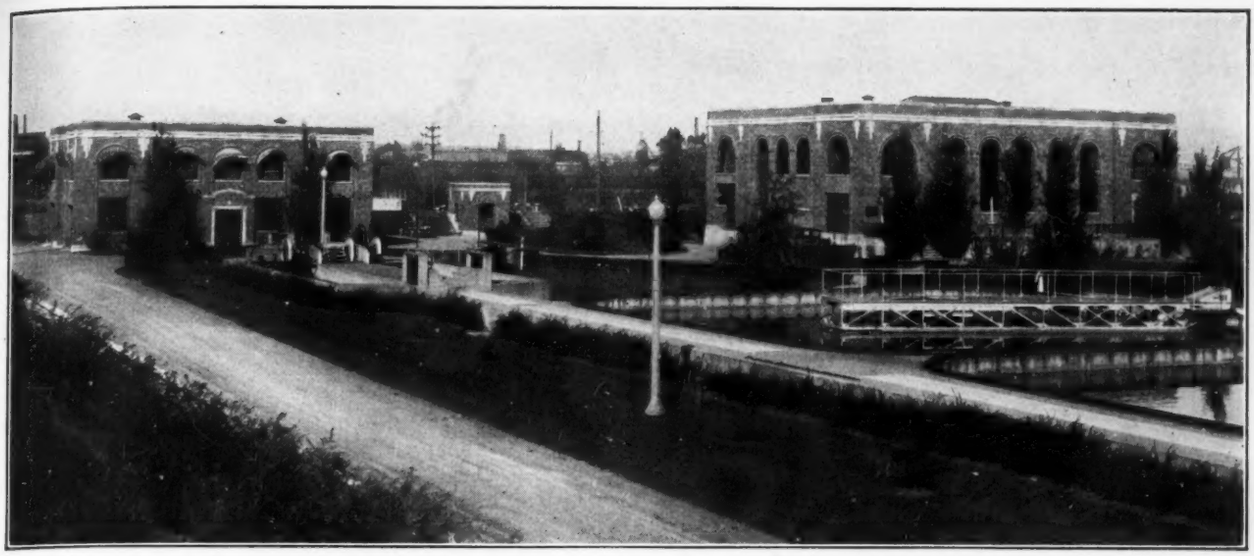
In the United States, tests have been made on various devices, such as the Dwight-Lloyd sintering apparatus (a combination of a traveling metal grid with a drying and a burning zone), the Nichols-Herreshoff furnace at Dearborn, Mich., and Industrial Associates spray-drying scheme now in use at Plainfield, N. J. Such studies may prove applicable primarily to the larger projects. Whether they have a bearing on the small projects is a question, which only future development will determine.

Value of Experimental Work

The interest of research workers has continued throughout 1934. Many experiments on chemical treatment have been tried. The principle laid down in 1897 by Archbutt and Deeley of reuse of previously deposited precipitates has been revived in several forms. The importance of adequate mixing and coagulating devices is now emphasized to secure economy and efficiency. The first phase of the renaissance of chemical treatment brought forward many different procedures, which are now in process of appraisal. The consideration of seasonal application of chemicals in special situations appears especially noteworthy as a means of extending the efficiency of sedimentation processes.

In the field of sludge dewatering, research workers have been studying the value of elutriation (as proposed by Genter), filtration, and conditioning by various chemicals. So far, elutriation seems most successful when applied to digested sludge. For sludge conditioning, ferric chloride (with or without lime) seems generally most popular, although lime alone has proven useful in some instances—principally on digested sludges.

Research on the activated sludge process has been carried on at Cincinnati by Hoskins and his associates [1934 Annual Report of the Surgeon General of the U. S. Public Health Service (pp. 34-35)], who conclude that the activated sludge process is essentially biological, depending on the maintenance and proper functioning of biological life which has the property of absorbing or coagulating and oxidizing the colloidal and suspended matter. An experimental plant has afforded opportunity to study "bulking" and determine its approach, although further research is needed to determine its control or prevention. A practical test for the rapid determination of dissolved oxygen in sewage-sludge mixture in the



Treatment Works of the Greater Peoria Sanitary District, Peoria, Illinois. (Greeley and Hansen, Engineers.)

aeration tank was described by Theriault and McNamee in the May, 1934, issue of *Sewage Works Journal*. The zoogleal masses of bacteria in efficient activated sludge have been studied and the bacterium, which reproduces the zoogleal masses and forms a coarse granular quick settling floc, has been isolated.

While the depression may have worked hardships on many in the varied walks of life, it provided a breathing spell for workers in the field of sewage treatment and sanitation, whereby time was gained for study of operating and maintenance problems, experiment and research. Thereby, much has been accomplished, with consequent saving in construction and operation costs.

Activated Sludge Design Improvements

Among the elements of design developed by The Sanitary District of Chicago for the more economical construction and operation of its activated sludge plants has been the use of wider aeration channels, up to 34 feet; the reduction in the number of water bearing walls in the aeration batteries, and the use of tank bottoms as footings for the longitudinal walls; the use of coarser diffuser plates, than heretofore, with a reduction in the number of rows of plates; and, the use of air lifts for control of removal of sludge from the final settling tank and its return to the incoming sewage.

Chemical Treatment

During the year, the Providence (R. I.) plant definitely turned from chemical precipitation, when remodeling began for activated sludge. However, other developments at Dearborn, Birmingham, York, Neb., Perth Amboy, Raleigh and New York City, Minneapolis, St. Paul and elsewhere indicate continued interest in the development of chemical treatment.

At Dearborn, changes are reported to have improved the chemical field, flocculation and settling. Ferric chloride and lime are reported as still in use, but paper is discontinued. The old pebble mill is being utilized to mix the sludge, ferric chloride and lime before application to the vacuum filter. The Nichols-Herreshoff apparatus for drying and incinerating the sludge cake has just gone into operation.

At Perth Amboy, N. J., under a PWA allotment, a chemical treatment plant (Laughlin type) is nearing completion (see cover picture). This is designed to treat flows of 10 m.g.d., using ferric chloride and lime; and also paper, if desired. Air mixing will be used in the flocculation tanks. Two 80-foot diameter Laughlin settling tanks are installed, each with a 1-hour detention period, at flows of 10 m.g.d. Sludge will be dewatered on Oliver-type vacuum filters.

Two chemical purification plants embodying the modified Guggenheim Process are being planned for Raleigh, N. C., each with an average capacity of 3 m.g.d. and a maximum of 4.5 m.g.d. The procedure includes chemical treatment, with ferric compounds and lime, and incineration of the sludge cake. The zeolite treatment of the effluent and the recovery of coagulant from the incinerator cinder will not be employed.

In the New York City program, an allotment of $1,867,000 has been secured from the PWA for the construction of the Coney Island Sewage Treatment Works,* with a nominal capacity of 35 m.g.d. This plant will utilize chemical precipitation by means of flocculated iron salts, sedimentation, rapid filtration and chlorination. The sludge will be digested and dewatered with a vacuum filter. The plant will operate on the chemical and chlorination basis during the bathing season only. At Coney Island, tests are also being made by the Filtration Equipment Corporation on a flow of 30,000 to 40,000 g.p.d., in coöperation with the New York City Department of Sanitation. Various modifications of chemical treatment, with and without magnetite filter, in service, are being made. A small vacuum filter is installed for sludge handling and the dryer and incinerator is of the Wedge type, which is similar in principle to the Herreshoff type.

At Birmingham, Ala.,** Hendon has been operating the new Shades Valley chemical treatment plant, utilizing chlorinated-copperas and chlorine with various schedules, including the return of sludge from the final clarifier to the incoming sewage. Storm flow is said to be settled and chlorinated up to twice the future average dry flow on a design basis.

*Elsewhere in this issue appears an article by R. H. Gould which describes the proposed Coney Island plants, about to go under construction.—*Editor.*

**The Birmingham plant will be described in our March issue by H. H. Hendon, who also will present operating methods and results.—*Editor.*

Sprinkling Filters with Revolving Distributors, Williamsburg, Va.

Supplementing Sedimentation

The Engineering Commission (PWA) in its report of April 30, 1934, on the Sanitary District of Chicago program, recommended that greater progress could be made towards meeting the sewage purification requirements of the decree of the U. S. Supreme Court by continuing the use of the Imhoff tanks constructed at the West Side plant, "pending further investigation and experimentation as to the best means of improving the quality of the effluent." It was not clear to the Engineering Commission (PWA) "that the activated sludge process is the best means of supplementing the treatment on the West Side Imhoff tanks."

Seasonal Use

The seasonal use of chemical treatment has appealed to many engineers in dealing with the problems of pollution where adequate dilution is available to supplement sedimentation for the greater portion of the year. Consideration was given by Eddy-Greeley-Gregory to this application for the District of Columbia; but, based on the recommended maintenance of 50 per cent oxygen saturation in the river and the lengthy period required for such treatment and its consequent cost, activated sludge was recommended by them. For the present, however, only sedimentation is being planned, while selection of secondary treatment is under discussion. In the situation at Minneapolis-St. Paul, a relatively short and maybe infrequent period of supplementary treatment is expected, for which chemical treatment has been recommended by the Bass-Carey-Kutz Commission (PWA), Greeley and Hansen, and Fuller and McClintock.

At Grand Rapids, Mich., Oklahoma City, Plainfield, N. J., Atlanta, Ga., and elsewhere, experiments have been made on chemical treatment to improve sedimentation efficiencies. At Plainfield and Oklahoma City the process is in use. In addition to 10 Imhoff tanks which the North Shore Sanitary District (Illinois) has already built and is accustomed to operate, another is projected at Waukegan (50,000 population) to handle 10 m.g.d. sewage, with a flexible layout to provide for a variety of possible coagulants, plus chlorination. In this case, the coagulants will be used during the bathing season. The seasonal use of chemicals and chlorination is also to be practiced at Coney Island (New York City program) during the bathing season. The Shades Valley plant at Birmingham, Ala., is also operated on a seasonal basis, using plain settling in the winter or in wet seasons.

Sludge Handling and Disposal

Mechanical Filtration

Greeley and Hansen (*Illinois Engineer*, Dec. 1934) point out that the estimated costs for mechanical filtration of raw or digested sludge compared with standard digestion and sand drying indicate that such methods are not economical for plants serving less than 50,000 persons. With plants serving 100,000 population or more the estimated cost of mechanical filtration of raw sludge compares favorably with combined digestion and sand drying costs found in certain Illinois plants. The ultimate disposal of the sludge cake requires study and may need drying and incineration.

Keefer (WATER WORKS AND SEWERAGE, Dec. 1934) estimates that at Baltimore, digested solids can be elutriated and dewatered by vacuum filters for about 55 per cent of the cost of air drying on open sludge beds. However, in his opinion, such procedure is more applicable at large sewage works. At small plants, the bed dewatering of sludge is likely to be cheaper.

Sludge Marketing

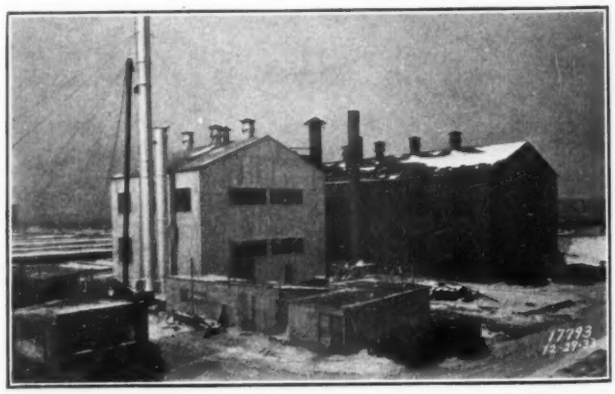
The disposal of sludge still proceeds on a varying basis. On digested sludge Baltimore, Md., gives away its sludge, as removed from the drying beds, loading free of charge. Rumsey reports the sludge of Grand Rapids is dried on outdoor beds, then heat dried to 14.5 per cent moisture, ground and bagged. About 1,000 tons annually is produced with a nitrogen content around 2.5 per cent. A greenhouse, orchard, nursery and lawns demonstrate to visitors the value of the sludge. The income for the year ending March 31, 1934, from sludge sales was $4,813.75, received from about 570 tons. At Peoria the air dried sludge is removed by farmers from the pile. It has an average nitrogen content of 3.5 per cent. At Dayton, Ohio, Tatlock has made notable progress in sludge preparation and marketing on a paying basis.

Progress in Sludge Incineration

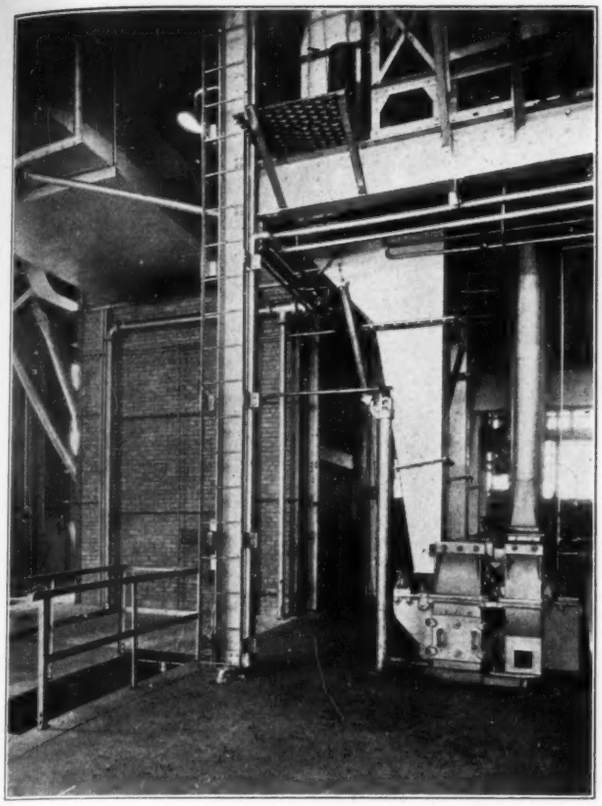
The recent full scale installation of a Herreshoff-type incinerator at Dearborn has already been referred to, as were others under experimental development.

In the Chief Engineer's 1935 budget report for The Sanitary District of Chicago,* Harrington recounts the operation of a large scale experimental sludge filtering and incinerating plant at the Chicago West Side Works from August 5, 1932, to May 18, 1933. This was

*Annual Budget Report to the Board of Trustees making recommendations for 1935.—Philip Harrington, Chief Engineer, The Sanitary District of Chicago.



Experimental Drier and Incineration Plant. Chicago Sanitary District.



Chicago Experimental Sludge Incineration Plant. One of the Raymond Mills Preparing Sludge Cake for Further Drying and Incineration. (See Text.)

equipped with an Oliver vacuum filter of 570 sq. ft. filtering area, and a rotary heat dryer, producing cake dried to a moisture content of about 20 per cent. The dried cake was incinerated in the furnace under the drier, a small amount of coal being added occasionally. The vapors were passed through a vapor condenser and scrubber box.

On February 1, 1934, a remodeled plant was put in operation, utilizing some of the original equipment, principally the vacuum filter and its auxiliaries. The new drying and incinerating unit consisted of a two-stage system of drying, using preheated fresh air and pulverizing mills wherein the sludge cake was thoroughly disintegrated and efficiently dried. The contaminated gases and vapors from the drying cycle were reheated and subjected to a temperature of about 1800 deg. Fahr., whereby all odors were completely destroyed.

A portion of the dried sludge was diverted to mix with the wet filter cake feed, the balance passing to the secondary drying and pulverizing unit, where it was disintegrated to pass through a 200-mesh screen, and blown direct to the furnace to be burned in suspension as pulverized fuel. The furnace gases, ranging from 1600 to 1800 deg. Fahr. were passed through 2 preheaters in series. Under this system, no gas, vapor or dust were released to the atmosphere until passed through a furnace zone with a minimum temperature of 1400 deg. Fahr.

After 9 months of successful operation, a cage type of mill was installed. Alterations were made in the method of firing whereby sludge coming from the first stage drying mills was fired directly, through a separate burner. The secondary mill hereafter will be used only for grinding coal required in starting the plant up or to meet any heat deficiencies. Prior to burning, the sludge now is pulverized only to pass a 48-mesh screen. The revised unit went into service on December 28, 1934.

The Harrington report concludes that the operations in 1934 definitely prove this method of sludge disposal to be efficient, economical, and free from nuisance.

Gas Utilization

The utilization of the gas from sludge digestion is progressing. At Springfield, Ill., Walraven has adapted a gas engine to run a blower for the activated sludge plant. Early in 1934, the gas was sufficient to produce power to carry over 94 per cent of the aeration load. In general, Walraven is of the opinion (*Illinois Engineer*, Dec. 1934) that in an average activated sludge plant about 67 per cent of the power required can be developed from gas produced by adequate digestion. At the Peoria Sanitary District, Longley reports that a plan is under way, aided by a PWA grant, to utilize gas from the sludge digestion tanks to operate a gas engine (approximately 500 hp.) driving a 15,000 cu. ft. min. positive displacement blower and a second gas engine driving a 250-kvs. electric generator. At Newark, N. Y., and Durham, N. C., both new plants, gas engines supply an appreciable percentage of the power requirements for operating activated sludge plants.

Odor Control

The use of chlorine for odor control has been thoroughly covered by various writers (see Report of A.P.H.A. Committee on "Chlorine in Sewage Treatment"). However, some novel arrangements have been made in the recently completed Ravinia plant of the North Shore Sanitary District, in which roofed-over Imhoff tanks and glass-covered sand drying beds are used, with provision for venting all gases from the plant to an ornamental tower rising 65 feet above the bluff behind the plant. Fans are available for expediting drying and changing the air over the tanks. These precautions were taken because of the immediate proximity to a high-grade residential neighborhood.

Hazards of Polluted Water to Navigation

Whereas authorities have frequently discussed the hazard of polluted water when used for water supply, bathing, shell fish growing, industrial purposes, or recreation, as well as for fishing, milk supplies and ice cutting, the hazard to navigation has seldom been touched.

In a report on the creation of a Sanitary District embracing Minneapolis and St. Paul, the Minnesota State Board of Health recently pointed out the hazards of polluted water *as it exists in the Twin City area to bathers and to boating. "Infections similar to those acquired by bathers resulted to those operating boats on the river." . . . "These infections result from handling the two lines and through other unavoidable contact with the water."

The students of the University of Minnesota are not allowed to row on the river below Minneapolis and St. Paul because the State Board of Health considers the river unsafe for aquatic sports.

Stream Purification Data

The U. S. Public Health Service has maintained a staff of research workers for over 10 years at Cincinnati, who have studied stream purification problems, in particular on the Illinois, Mississippi, Ohio and Potomac rivers. To their skill is due a large portion of the advance.

The stream pollution investigations of the U. S. Public Health Service were continued in 1934 in experimental channels to determine the rates of atmospheric reaeration in deaerated water. The rate of oxidation of sewage

*Appendix C. Metropolitan Drainage Commission, Jan. 1–Nov. 6, 1933.

sludge deposits was indicated by laboratory tests to be considerably lower than that of normal biochemical oxidation of sewage. During 1934, the Illinois State Sanitary Water Board made an extended survey of the Illinois River and in particular the industrial waste situation.

For nearly 9 years the Sanitary District has been keeping a record of the condition of the Illinois River to determine the improvement made by its sewage treatment construction program. The changes produced by the creation of pools in the upper river in connection with the Illinois Waterway are also of interest, in that the rate of reaeration is affected thereby and the formation of ice sheets encouraged. The report of the Chief of Engineers, United States Army (Sen. Doc. 184, 73rd Congress, 2nd Session) on the Illinois River, affords a review of the problem to date. It states "that aside from sanitary requirements, the minimum annual average flow from Lake Michigan required to meet the needs of a commercially useful waterway in the Illinois River, is a direct diversion of 1,500 cubic feet per second in addition to domestic pumpage by the city of Chicago. It does not appear possible to arrive at a conclusive determination whether this flow will afford suitable sanitary conditions on the waterway after the sewage purification plants at Chicago have been completed and placed in operation."

Influence of Controlled Stream Flows on Treatment

The development of storage at the headwaters of some of the large streams in the United States may have a bearing in the future on the degree of sewage treatment required, particularly in critical periods of low natural flow.

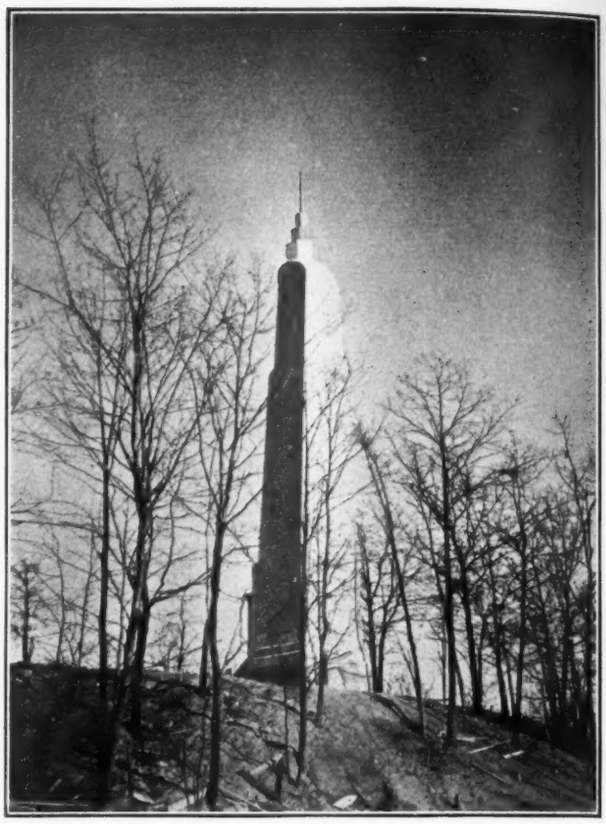
Such storage may likely become a factor in the Minneapolis-St. Paul situation to tide over periods of low water flows and may have a bearing on other streams like the Ohio. A comprehensive analysis of the entire situation on a river valley like the Ohio, taking flood protection, water supply, sewage disposal and navigation would be of interest, giving due weight to each factor. Heretofore, navigation has apparently taken the fore with little regard to water quality.

Waterway standards still concern the sanitarian. Streeter* has summed up the recent tendencies for various situations. He states, that where the public health is not involved, the minimum dissolved oxygen standard of not less than 3 or 4 parts appears most popular. On the other hand, on the upper Mississippi River at Minneapolis-St. Paul, the Minnesota State Board of Health has named a standard of 2 parts per million in the river for 90 per cent of the time of each of the summer months of the average year, above 1 part for short periods and always above zero parts. Eddy-Greeley-Gregory recommended for the Potomac River in the District of Columbia and below that a 50 per cent saturation of dissolved oxygen be maintained, with a removal of 98 per cent of bacteria from the sewage in the warmer months.

Storm Water and Industrial Wastes

In many situations where streams are practically dry in the summer months, the effect of discharge of sewage laden storm water overflow from combined sewers may become important. The need of storm water treatment has been recognized at North Toronto and at Columbus, Ohio. In both cases considerably more than the some-

*Tendencies in Standards of River and Lake Cleanliness, Reprint No. 1643, from Public Health Reports, Vol. 49, August 24, 1934, p. 981-982.



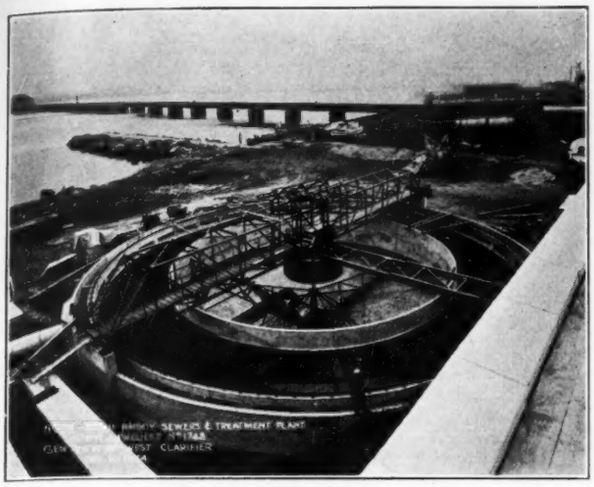
Odor Relief Tower at Ravinia. (North Shore Sanitary District, Illinois.)

what conventional 1.5 times the dry weather or average flow is carried to the treatment works and given treatment.

At Columbus,* with a future estimated average sewage flow of 125 gal. per cap. per 24 hr., the capacity of interceptor in the section receiving storm sewage ranged from 600 to 2,110 gal. per capita per 24 hrs. Storm standby tanks have been provided at Columbus with a detention period of 30 minutes, when the rate of flow of excess storm water through them is equal to six times the average dry weather rate of flow. At Columbus twice the average dry weather flow goes to the treatment works. On this basis up to eight times the average dry weather flow receives some treatment.

Under some situations treatment of the sewage in dry weather, with raw sewage entering the stream in wet weather may leave an objectionable condition. On this a recent case in Illinois is in point. The Illinois Supreme Court handed down, in 1934, an interesting decision (Barrington Country Club et al. vs. the Village of Barrington, No. 22018, opinion filed June 15, 1934). The village of Barrington operates a system of combined sewers with a treatment works emptying into a watercourse with practically no flow at time of low water. Complaint was brought largely because of storm overflows. The Court held that the fact that a city or village is given a permit under the Sanitary Water Board act of 1929 to construct a sewer system and treatment plant and to discharge the efflux thereof into a stream or water-course does not bar a suit by riparian owners to enjoin the municipality from so polluting the stream or increasing its flow as to injure their property rights, especially where the permit itself provides that the authority given "does not in any way release the permittee

*Intercepting Sewers and Storm Standby Tanks at Columbus, Ohio. Gregory, Simpston, Bonney and Allton, Proc. Am. Soc. C. E., October, 1933, p. 1289.



Clarifier and Up Flow Magnetate Filter (Empty) at Perth Amboy, N. J. Plant Nearing Completion.

from any liability for damage to person or property caused or resulting from the installation, maintenance or operation of the sewerage system." This decision indicates a tendency of the courts in Illinois to hold that storm overflows from combined sewers must be treated in certain situations.

More of a problem than storm sewage is that of the effect of industrial wastes, which can not be handled by sewage treatment works. The coöperation of industry is being sought and obtained in many instances, looking toward a satisfactory solution of the important problem.

Rumored Legislation

Legislation, giving the Federal Government control over stream pollution and particularly industrial wastes has recently been suggested. Neither its purpose nor scope is clear from newspaper and other reports (*Chem. and Met. Eng.*, Dec. 1934). The constitutionality of such broad legislation has generally been questioned in the past. However, such suggestions raise the question of the value of Federal control as against State control.

The State Sanitary Engineers have been working on the problem of stream pollution for a number of years and in general have accomplished much. Some questions arising need to be considered for uniformity of procedure by watersheds, but by coöperation or pacts the States should be able to work the problems out.

A striking example of interstate agreements is the Ohio River Interstate Stream Conservation Agreement comprising the health departments of eleven states which lie in whole or in part on the Ohio River watershed, and the Great Lakes Drainage Basin Sanitation Agreement comprising the eight states bordering on the Great Lakes. Under these agreements the respective health departments coöperate closely on stream pollution and in fixing minimum degrees of sewage treatment. Particularly noteworthy has been the cleaning up of phenol pollution and the recent effort to relieve streams from acid mine drainage in the Ohio basin.

Patents

Of late years the attention of sanitary engineers has been focussed on patents of several types. In the early days the septic tank patent aroused much interest. Later came the Imhoff tank patent. More recently, certain patents have been seriously questioned on activated sludge and separate digestion, as well as minor matters. In the past, the practicing engineer in the United States has been free handed in disclosing to the public the discoveries and improvements made in the art, particularly when done at the expense of the public. Whether such a policy is now to be reversed remains to be seen. Where litigation exists, the engineer should inform both himself and his clients of the situation and take such steps in his handling of contracts and construction as may be recommended by competent legal advice.

Acknowledgement.—Acknowledgement is hereby made to all those who have aided by furnishing information, photographs or data. If some topic has been omitted or error made, it is only due to lack of space or time to cover so wide a field as sewage treatment in the United States.

▼

Barbour Nominated as Next President A.W.W.A.

President Harry E. Jordan and the Board of Directors of the American Water Works Association have submitted the name of Frank A. Barbour of Boston, Mass., as their nominee for the office of President of the Association in 1935-1936—such action being tantamount to an election.

Frank A. Barbour

Mr. Barbour, who is an outstanding Consulting Engineer in the water supply and sewerage fields, has served the Association in many and valuable ways, as he has also the New England Water Works Association, of which he is a Past-President and Honorary Member. A Canadian (New Brunswick) by birth, he is an American by adoption. He served the U. S. War Department exceptionally and tirelessly during the World War; got things done in the manner for which he is well known.

Frank Barbour, among other things, is a business man. He is President of the New England Pressed Steel Company, and having also served as Director of various companies and associations, he has had those experiences which render him the efficient executive that he is, and a valued man for the nomination to the Presidency of the A.W.W.A.

Herewith, WATER WORKS AND SEWERAGE casts its vote for Mr. Barbour.

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E. B. Besselievre to Spend aYear on Missionary Work in South America

Edmund B. Besselievre, Eastern Manager of the Sanitary Engineering Division of The Dorr Company, Inc., sailed on Saturday, January 26th, for a year's visit to South America. He will visit practically all of the South American countries for the purpose of investigating and furthering the application of modern methods of water, sewage and trade waste treatment on that continent.

Mr. Besselievre postponed his trip in order to officiate as President of the New York State Sewage Works Association which he helped to organize, has served in various capacities during its life and has seen it grow to be the largest sewage works association in America.

ARE WATER UTILITIES A GOOD INVESTMENT?

By CHARLES H. CAPEN, JR.*

DURING the boom period of the late twenties, a banker gathered certain statistics and came to the conclusion that less than ten per cent of all business ventures continued to prove successful for more than a very few years. His study was intended to represent a true cross section of all business, but only casual consideration need be given utilities to realize that their life far exceeds the average.

When a utility finds that it is unable to make a profit, the usual recourse is to raise its rates. Sometimes such a procedure sounds the death-knell of the enterprise, but more often a new lease on life is obtained. A utility seldom has direct competition and therefore does not have to worry so much about getting customers as in maintaining the confidence of those already using the service rendered, and at the same time handling its finances in such a manner as to show a reasonable profit. Frequently this is more easily said than done and utilities have always been a good target at which certain people or groups may shoot with more or less impunity. Water utilities, both municipal and private, are no exception to this rule.

Are Water Utilities a Financial Success?

Like every other business man, the waterworks official has myriads of his own problems to solve but he may frequently learn much to his advantage by studying the problems with which another has to cope. In line with the opening paragraph, the following questions might well be asked: "To what extent are waterworks utilities a financial success?" and "What is the reason for failures?" The following discussion may serve to throw some light on this subject.

As in the case of previous articles in this magazine, the writer has chosen waterworks utilities in New Jersey as an example—this because of a greater familiarity with them, and partly because the annual reports to the New Jersey Public Utility Commission yield much useful information.

While the degree of financial success of a waterworks system depends principally on the actual per cent of profit accruing, nevertheless no one can dispute the fact that a deficit shows positively that the venture is not successful. While one deficient year does not condemn a system, a series of them does. Furthermore, the general trend can be obtained by an analysis of past records.

In reporting to the Utility Commission, waterworks are divided into Classes A, B, C, and D. The first three classes, which will be considered collectively, include all those having gross earnings exceeding $10,000 per year, while Class D includes those earning less than that amount per year. A table has been prepared which shows the total number reporting in each class, together with the number showing a deficit. This was done for both municipal and private systems. Figure 1 shows graphically the results of this tabulation by years for the periods over which the figures are readily available.

During the early years, the Class A, B, and C municipal supplies made a remarkably good showing. The effect of the war period made itself felt with an increase

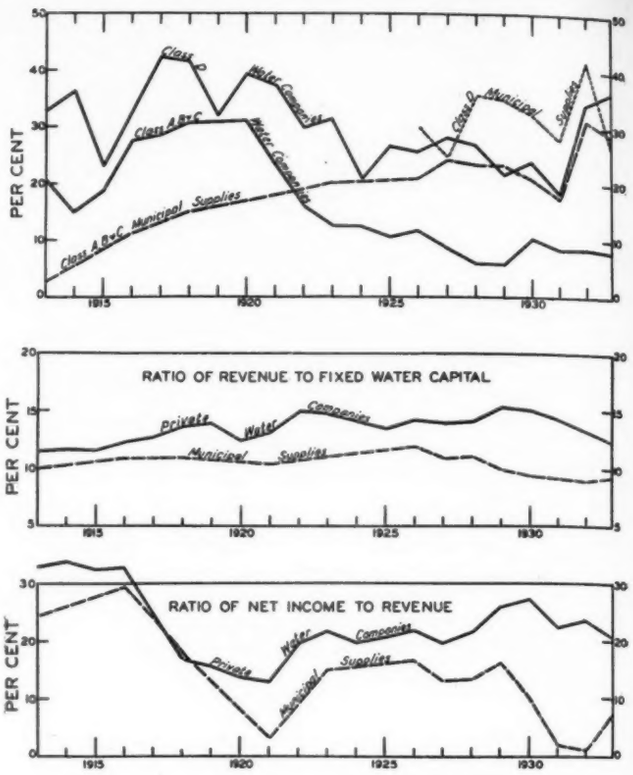

Fig. 1 (top).—Per cent of New Jersey Water Utilities Showing a Deficit. Fig. 2 (center).—Ratios (Weighted Averages) of Revenue to Fixed Capital. Fig. 3 (bottom).—Ratios (Weighted Averages) Net Income to Revenue.

in the per cent showing deficits, which continued to increase until the late twenties. The succeeding improvement with prosperous years was halted and reversed by the late depression.

The large private water companies showed a higher per cent of unprofitable ventures during the early years; the situation becoming worse during the war period. After 1920 a decided improvement occurred, caused by grants of increased rates by the Utility Commission. The most significant point in regard to this group is that they have not been affected by the depression as much as the others. In fact, in the period from 1928 to 1933 inclusive, the greatest number of large companies showing a deficit in any one year was four. In this group, the names of two companies appear and have appeared regularly, for the last ten years. The reason in one case is that the company acts mainly as a broker, transporting water from one point to another at wholesale rates, with old time contractural obligations that make profitable operation impossible. Its property is now up for tax sale. In the other case, the company formerly supplied a certain municipality with water, when a small competing company was established to furnish water to a section not supplied by the larger company. Popular sentiment caused the municipality to buy out the smaller plant, enlarge and extend its mains throughout the municipality and finally to sell water at lower rates. Losses under such conditions were inevitable and the company has only kept running by virtue of money supplied from the profits of the electric utility, which is jointly owned. Eliminating these two persistently losing ventures shows that the operations of all the large water companies in New Jersey to have been profitable during the years 1928 and 1929.

The Class D municipal supplies have followed a general trend somewhat similar to the large supplies during

*Consulting Engineer, West Orange, N. J.

TABLE 1.—AVERAGE PER CAPITA RECORDS OF WATER WORKS

(Determined by Averaging the Per Capita Record of the Individual Works)

	1915				1923				1928		1933	
	32 Private Works of U.S.*	5 Private Works of N.J.	11 Municipal Works of U.S.*	5 Municipal Works of N.J.	32 Private Works of U.S.*	5 Private Works of N.J.	11 Municipal Works of U.S.*	5 Municipal Works of N.J.	5 Private Works of N.J.	5 Municipal Works of N.J.	5 Private Works of N.J.	5 Municipal Works of N.J.
Book value of property.	$35.00	$32.00	....	$39.30	....	$41.30	....	$54.00	$47.70	$59.30	$49.30	$64.30
Gross annual revenue....	3.55	4.89	$2.95	4.12	$5.54	6.49	$3.92	6.12	7.93	5.96	6.95	5.26
Total operating expenses	1.70	2.16	1.90	1.50	3.24	4.10	2.44	3.44	4.55	3.43	4.01	3.13
Net revenue**	1.85	2.73	1.05	2.62	2.30	2.39	1.48	2.68	3.38	2.53	2.94	2.13
Rate of return (per cent) on book value.....	5.3	8.4	....	6.7	....	5.8	....	5.0	7.1	4.3	6.0	3.3

*Figures in these columns taken from Metcalf (1).
**Includes bond interest, whereas data used in Figures 1 and 3 do not.

recent years, in which the figures were readily available. They have always fared rather poorly, however, as is indicated by the fact that 39 per cent of them showed deficits in 1913.

The smaller Class D private companies have had about as precarious an existence as their municipal brethren. Their course has been very spotty, improving somewhat by means of rate increases during the late twenties, but reacting rapidly to the depression. One point that should be noted, however, is that the really successful Class D companies have been able to expand their operations and step up to Class C, leaving the weaker companies in Class D.

It is important to note that in the data from which the figures were taken, "Net Income" or "Net Deficit" is the balance left after deducting from gross revenue, the following items: operating expenses, taxes, amortization and interest on bonded indebtedness. This tends to show the municipal supplies in a less favorable light than the private companies because the stock dividends of the latter (which are to some extent analagous to part of the bond interest payments of the former) are subsequently deducted from "Net Income" to show final surplus or deficit. In Figure 1, little effect would be noted in the case of the large supplies if this were taken into account, but the curve for the Class D companies would be several per cent higher in most years if a proper adjustment could be made. Since legitimate stock issues, in the case of private companies, are comparable to municipal bond issues it follows that all dividends up to say 5 per cent should be deducted from net income before determining whether or not the companies had deficits as compared with municipal supplies. To do this would involve a great amount of detail computation, the value of which is doubtful in view of the fact that the figures would be hypothetical.

Why Are So Many Water Utilities in the Red?

The answer to this question may best be given by a study of Figures 2 and 3, but a word of caution must be given to the effect that some knowledge of the underlying data must be had before the true significance of the curves can be realized.

Figure 2 was obtained by adding up all the figures for fixed capital and all the figures for operating revenue for the A, B and C water utilities, municipal or private, separately for each year. The quotient or ratio of revenue to fixed capital, expressed in per cent, gave a weighted average figure which was plotted for each year. Obviously this led to a predominance of the influence of the large supplies. For some of the years, a trial was made of determining the ratio separately for each supply and finding the arithmetical average of these ratios. This average was universally higher than the weighted average, indicating that the larger supplies can apparently do successful business on a lesser ratio of income than the smaller ones. The word "apparently" is used advisedly, because a study of the records reveals the fact that some of the larger companies made revaluations of their property during the twenties and now have a gross income of nearly the same per cent as before, but on an artificial or increased rate base. Were it not for this write-up, the companies would now be found to be receiving more than 15 per cent annually on their fixed capital instead of the amounts shown.

The very much lower per cent of revenue shown by the municipalities (as compared with private companies), can be explained mainly by lower rates. Taxes account for only a small part of the difference because nearly two-thirds of the taxes paid by the companies are returned to the companies in the form of fire protection charges. On the average, the net difference between taxes paid by the companies and fire protection revenue repaid to them amounts to only 10 per cent of the total revenue and only 1½ per cent of the fixed capital. Thus if we say that on the average the companies are now earning 12½ per cent on fixed capital and the municipalities 9 per cent, the gross difference is 3½ per cent and the net or comparable difference, after making allowance for taxes and fire protection, is 2 per cent. This latter figure shows why municipal supplies have had greater deficits to-wit: their earnings have not been sufficient because their rates are too low.

The picture may be further clarified by a study of Figure 3. Here are shown the ratios of net income to total revenue, expressed in percentage. Here again the totals for all the Class A, B and C utilities reporting, separated as to municipal or private, were obtained and results expressed on that basis, giving weighted averages. Again the influence of the large supplies predominates and the arithmetical average gives a larger figure in every case. The inference as to lack of sufficient income on the part of the municipal supplies is striking in this curve. The effects of the war, the post war recovery and the depression are easily apparent. The post war recovery and consequent stabilization of the companies, because of increases in rates, has never been enjoyed by the municipalities and it is doubtful if this could be more effectively demonstrated than by a curve such as shown in Figure 3.

Comparison With Other Parts of the U. S.

In drawing conclusions from these figures, it is obvious that there are many exceptions to the rule. Furthermore the water utilities in only one state (New Jersey) have been investigated. However, the figures are drawn

from reports of about 170 supplies in 1913 followed by an increase to 223 in 1933. Certainly this comprises a large enough group to be fairly representative.

For the purpose of affording a certain degree of comparison, Table 1 has been prepared showing figures presented by Metcalf (1) together with figures from some of the larger supplies in New Jersey. These figures do not of course represent the large group mentioned in the preceding paragraph but permit drawing general comparisons.

In any figures involving per capita records, allowances must be made for the fact that many discrepancies may exist in the matter of population served. Furthermore in New Jersey, probably to a larger extent than elsewhere, whole communities are ofttimes served wholesale and corrections must be made for this. In general the gross and net revenues as well as rate of return in New Jersey, have been larger than elsewhere. The private companies in New Jersey have apparently fared pretty well as is evidenced by a minimum rate of return of 5.8 per cent, which occurred in 1923. The New Jersey municipal supplies show a downward trend in rate of return largely on account of large capital expenditures, during the boom period, without corresponding increases in charges of water. By inference the municipal water works situation in the country at large must on the whole be rather gloomy.

Many other deductions may be made from this table particularly if it is studied and compared with Metcalf's original article (1) but further details will not be given here.

Conclusions

1. Water utilities on the average are more successful and safer business ventures than most lines of endeavor.
2. The larger supplies are more apt to prove financial successes than the smaller ones.
3. Rates charged by the larger companies are high at the present time and the future good-will toward them will be materially enhanced if they voluntarily cut rates to meet present conditions.
4. Rates charged by the small companies, while probably high compared to larger companies, appear nevertheless to be inadequate as a general rule. An investigation of the rate base, however, should be made before increases are granted.
5. Rates charged by municipally operated water utilities are generally too low and water departments cannot function efficiently unless granted relief, even though temporary, in the form of increased rates.

REFERENCE

(1) Metcalf—"The Financial Status of Water Works in the United States as of January 1, 1924"—Journal A.W.W.A., Vol. 13, No. 4, April, 1925, p. 375.

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Special Committee on Specifications and Tests for Activated Carbons

Matthew M. Braidech, chairman of the A. W. W. A. Committee on Specifications and Methods of Tests for Water Purification Chemicals, has appointed a Special Subcommittee on Specifications and Tests for Activated Carbons. The following comprise this committee:

L. C. Billings, Supt., Filtration, Dallas, Tex.

W. U. Gallaher, Supt., Filtration, Appleton, Wis.

F. W. Gilcress, Chemist, State Dept. of Health, Albany, N. Y.

G. L. Kelso, Chemist, Supervising Engrs., Inc., Greensburg, Pa.

Neil Kershaw, Chemist, Indianapolis Water Co., Indianapolis, Ind.

J. E. Kerslake, Chemist, N. S. Hill, Jr., Cons. Engrs., New York City.

Geo. R. Spalding, San. Engr., Hackensack Water Co., New Milford, N. J.

M. M. Braidech, Sr. Chemist, Baldwin Filters, Cleveland, O. (chairman).

The chairman and members of this committee are desirous of having the assistance of water works operators and the cooperation of manufacturers of activated carbons. All interested are invited to get in touch with some member or Mr. Braidech, chairman of this important committee.

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Burt B. Hodgman Dies After Brave Fight

Well Known as a Water Works Engineer—Admired and Loved as a Man

Burt Hodgman
(A snapshot made just prior to his fatal illness)

Burt B. Hodgman, Vice-President and Chief Engineer of the National Water Main Cleaning Company, died in New York City on January 20th after a long and brave fight for life—out of which he had gotten so much, and given as much to others.

Burt Hodgman was born in Coldwater, Mich., on May 6, 1877. He attended Princeton University, was well known then and since as a Varsity football player and was graduated as Civil Engineer in 1903. He thereafter served the Pitometer Company until 1907, when he joined the National Water Main Cleaning Company and made for this company a national reputation, built in no little measure on his ability, integrity, outstanding personality and popularity. Mr. Hodgman served also as expert witness in several valuation hearings in connection with state cases.

As a member of the American Water Works Association, since 1907, he served the Water Works Manufacturers Association for many years as Chairman of its Convention Entertainment Committee. He served in connection with conventions of the American, New England, Southeast and Southwest Associations, in all of which he was a member of, and therein built up large and genuine circles of friends. He was a member of the American Society of Civil Engineers; Machinery Club; Essex Country Club; the Princeton Club, and others.

Burt Hodgman will long be remembered by all who knew him, as an engineer and a man of outstanding personality and modesty.

He is survived by his widow, Grace Wilding Hodgman.

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NEW SEWAGE TREATMENT PLANTS IN OHIO.—During the past 5 years 15 new sewage treatment plants have been placed in operation in Ohio. With two exceptions these new plants are being operated under technical supervision. In addition to these 15 new plants, 6 existing plants have been improved either by rehabilitation or extension or both. Under the PWA provisions a number of sewage treatment projects have been inaugurated; 11 of these are under contract, and 3 projects have been approved.

THE ELIMINATION OF CHECK VALVE SLAM

By H. K. PALMER*

Los Angeles, Calif.

THE slamming of check valves when pumps are stopped constitutes a source of annoyance and often of expense to water works or sewage works and allied institutions. Many check valves have an annoying habit of slamming when it is least expected, while others placed on long lines may close quietly. Too sudden closing may easily cause a rupture in a pipe line, a feature which may be eliminated by inclusion of a large air chamber which will eliminate sudden pressure on the pipe but may cause such an abrupt closing of the valve as to crack the flap.

Check valve slam produced by a surge in the water column causes water hammer, with its consequent damage. When a pump suddenly stops, the water tends to continue in motion due to its momentum, and the gage pressure drops to zero. The force tending to stop the motion of the water is proportional to the static head on the pump and such force produces a negative acceleration in the water column according to the formula of mechanics.

$$F = Ma$$

where: F = Force producing acceleration; M = Mass of water; A = Acceleration.

Letting: A = Area of pipe, square feet; L = Length of pipe in feet; g = Acceleration due to gravity (32.2); w = Weight of a cubic foot of water (62.4 lbs.); h = Static head on the pump; Hf = Friction head; H = Total head; t = Time in seconds; v = Velocity in pipe:

One may: compute the force producting acceleration as being

$$F = h\ A\ w$$

And, the mass of water is found to be

$$M = \frac{A\ L\ w}{g}$$

Then:

$$h\ A\ W = \frac{A\ L\ w}{g}\ a$$

Or

$$a = \frac{h}{L}\ g \qquad \text{(See Figure 1)}$$

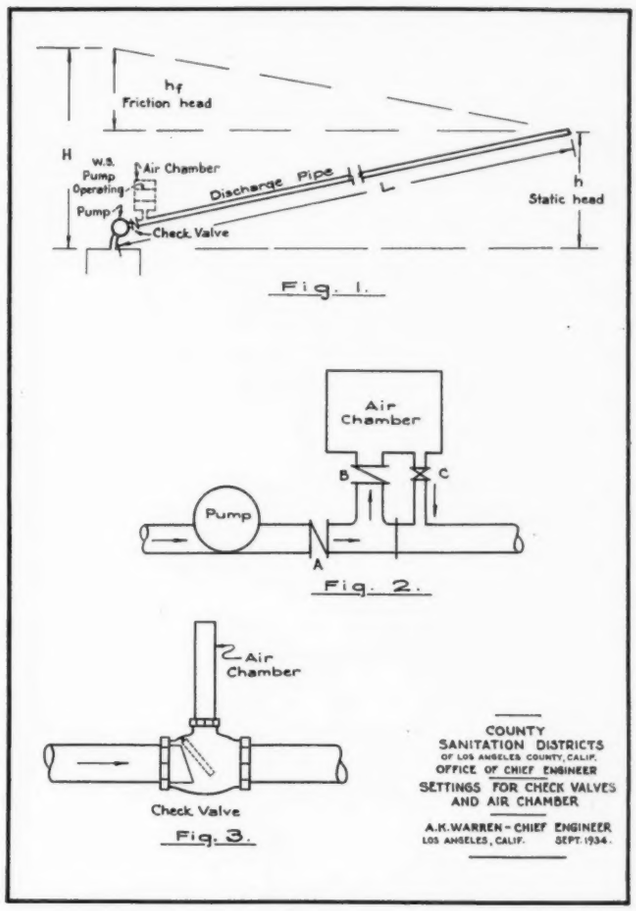
If v is the velocity in the pipe before the pump stops, the time (in seconds) required to bring the water to a stop will be

$$t = \frac{v}{a}$$

If the flap can come to its seat in [t] seconds or less, it is obvious that the water cannot move backwards and as the flap is moving against the stream it will be cushioned. On the other hand if the flap does not have time to become seated within [t] seconds, the water will start backwards and the valve will close with a slam.

Rapid vs. Slow Closing Checks

It is obvious that what is desired is *a valve that will close rapidly*. One way to accomplish this is to have the valve seat inclined to shorten the distance the flap must move, and another is to use a valve with an extended hinge pin and arm so the flap can be counter-



Arrangements of Air Chamber Installation to Eliminate Check Valve Slam and Water Hammer. Fig. 2 Illustrates a Successful Design and Arrangement of Connections—See Text.

weighted. This weight prevents the flap from opening fully, causing a small increase in pressure, but accelerates its return movement when the pump stops. On one test in which a four-inch pump was forcing water into a pneumatic tank under 65 pounds pressure, the slam was eliminated by hanging enough weight on the hinge pin arm to increase the pumping pressure less than one-half pound. This example offered one of the most difficult situations for slam elimination because the pump line was short and there was little mass to the flowing water; thus in one controlling formula $a = \frac{F}{M}$, [a] was relatively large; and in the other formula $t = \frac{v}{a}$, [t] was relatively small.

Where it is not feasible to close the check valve in less than time [t], the use of *a slow closing valve* should be considered, but such valves are expensive and must be so designed that the final closure is made very slowly. An air chamber will provide a cushion in case the valve does not close before the flowing water comes to rest and will protect the pipe against excessive pressure. Immediately after the pump stops, the value of the shock

*Chief Draftsman, Los Angeles County Sanitation Districts.

absorbing compressed air in such chamber is its cushioning effect, which tends to maintain the gage pressure on the line instead of allowing it to drop to zero. It will thus delay the stopping of the water in the main pipe but the pressure being maintained close to the pump, where the air chamber will normally be placed, produces excessive acceleration in the short length of pipe between the chamber and pump and although the valve will slam violently, the pressure on this section of the pipe will not be excessive. After the valve has slammed the water in the main pipe will slowly come to rest, and then back into the air chamber, the gage showing an oscillation about the static elevation, as a center, with maximum and minimum at approximately $(h + H_f)$ and $h - H_f$).

The air cushion in Figure 1 has purposely been drawn much larger than is recommended in order to illustrate the conditions. If, instead, it consists of a piece of pipe of the same diameter as the discharge pipe and about two or three diameters in height it will not supply enough water to permit any to flow backward through the check valve, thus avoiding a slam and at the same time preventing excessive pipe pressure. A surge will be set up with a maximum pressure of $(H = 2h)$ and minimum $(H = o)$.

A Successful Arrangement

An air chamber arrangement which has been found to work very successfully is shown in Figure 2. "A" is the main line check valve, "B" a check valve into the air chamber which should be nearly as large as "A" and set to allow water to enter the chamber. "C" is a gate valve or a plug cock smaller than "B." "C" must be opened or closed by trial until it limits the flow of water from the air chamber enough to prevent slamming of valve "A", and left in that position. The limited supply to the pipe damps out the surge, yet check valve "B" is large enough to admit a full stream to the air chamber and prevent excess pressure on the return flow.

To correct slam in an existing check valve, an air chamber can be built into the cover plate of the valve (Figure 3). Care must be taken to so adjust the size of such a chamber that sufficient water is returned to close the flap by the time the water comes to rest but sufficient to produce a slam.

This investigation was made about fiv years ago by the writer for the Los Angeles County Sanitation Districts and the data obtained applied to the correction of a number of troublesome conditions where valve slam was a problem. The writer is indebted to E. A. Rutledge of the Rensselaer Valve Coompany for testing the formulae on many successful water works installations. A. K. Warren is Chief Engineer and General Manager of the Sanitation Districts and A. M. Rawn is Assistant Chief Engineer.

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A National Water Policy and Plan

A National Water Plan of widespread import is advocated in Part 3 of the Report of the National Resources Board, which was released (January 18th) by its Water Planning Committee which was served by Thorndike Saville of New York, as Executive Engineer, and Morris L. Cook of Philadelphia, as Chairman.

The keynote of the suggested plan is federal participation with the states in evolving and carrying out a uniform and unified policy in the matter of water resources development, utilization and control in the United States. To develop proper and more productive uses and to correct harmful effects from existing or future abuses of water ways, the report recommends that five lines of action be undertaken:

1. The making of surveys, taking of inventories, and procuring of records of conditions which are fundamental in the evaluation and control of water resources.
2. To study and coördinate legislation by the federal and state governments in a coöperative effort on the part of all regulatory agencies interested.
3. Studies and experimentation in administrative regional planning in selected directions and in selected areas.
4. Detailed studies of representative projects on a complete drainage area basis.
5. The establishment of a federal advisory planning agency for purposes of coördination of control and usage of water resources—looking to the interests of all concerned.

The report places emphasis on the need for improved standards and practices dealing with tolerance of industrial wastes and municipal sewages in streams and other water courses. The committee points out that the nation needs some one organization which will be responsible for a continuous systematic study of water uses in all and manifold aspects which has a direct or indirect bearing on the life, habits and well being of every citizen. At once, there is adequate justification to draw up a considerable list of water resources betterment projects that merit immediate consideration and executions.*

The report contains an inventory of the nation's water resources which embraces assembled hydrologic data (much of which is original matter) on precipitation, surface and ground water (quantity and quality), drought statistics, flood control, waste disposal, surface and ground water storage.

The Committee comes to the conclusion that there need be no Water Dictator; and, that, what can be done locally or by states should be done by states; or, what can be done by groups of states should be so done. In any event, it believes, there will be problems which can best be handled by the Federal Government and nothing short of a national policy can deal effectively, justly and democratically with a situation that effects such a variety of interests.

*(Note.—The Water Resources Committee has just announced the appointment of H. R. Crohurst, Sanitary Engineer, U.S.P.H.S., who will report within 60 days to the committee on specific steps which can be taken immediately to reduce the pollution of American streams. In addition, a Special Advisory Committee is preparing a report and recommendations on methods and means of procedure in respect to coördination of the National and State agencies.—*Editor.*)

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P.W.A. Taking Inventory of Potential Projects

PWA has invited state and mmunicipal authorities to assist in getting up an inventory of possible public works projects which might be financed through it with some part of the $4,900,000,000 voted by Congress for work-relief during the next two years.

President Roosevelt and the PWA consider water works and sewerage projects as the most desirable types of municipal works to be built or extended in the new public works betterment program. This survey is being conducted through the PWA State Engineers and State Planning Boards and prompt coöperation, in reporting on possible projects, by water and sewage authorities is urgently requested by the President and PWA.

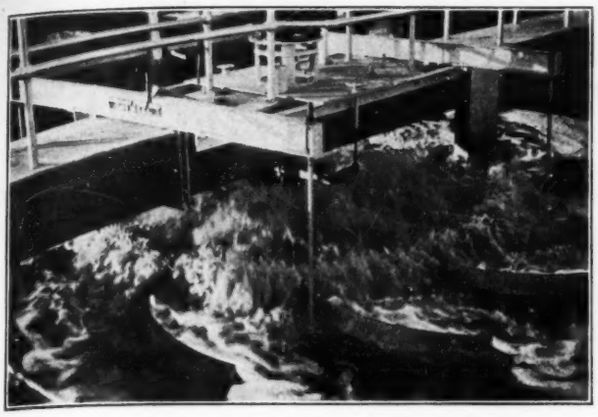


Fig. 4—Aerator in Operation at Top Speed. Note the 12 Hydraulic Jumps Created by the Angle Iron Weirs

THE CHICAGO COMBINATION AERATOR AND CLARIFIER

Results of Tests of Performance at Monroe, Wis.

By LEWIS H. KESSLER[1] and PHILIP F. MORGAN[2]
University of Wisconsin, Madison, Wis.

IN 1930 the senior author designed and supervised the construction and placed in operation the Sewage Treatment Works of Monroe, Wis. The plant is of the activated sludge type using mechanical surface aeration with a re-aeration tank, preliminary and final settling tanks, and a separate sludge digester with floating cover—the old septic tanks now being utilized for sludge storage.

Designed for seven surface aeration units of the mechanical type, the installation of one unit was postponed due to lack of funds. The empty tank has since been made use of for experimentation and research by the students in the Department of Hydraulic and Sanitary Engineering at the University of Wisconsin, wherein, through the courtesy of W. E. Trukenbrod, Chairman Sewage Plant Committee and other Monroe officials have given splendid cooperation and assistance. Every year, since the plant was placed in operation in 1931, several phases of experimental investigation have been conducted at the plant. The characteristics and behavior of the activated sludge process when treating a strong sewage involving heavy dosages of whey, cheese and dairy wastes, brewery and some slaughter wastes have constituted the principal studies.

The Monroe sewage is uniformly strong throughout the year and the daily domestic contribution is from about 3,500 people. Studies have indicated that in the spring, when milk plant receipts are at a maximum and but little whey is taken back by the farmers, the plant loading will be equivalent to sewage from 14,000 persons.

It was with some interest to the university staff that the Chicago Pump Company offered to equip the empty aerator tank with its newly developed "Chicago Aerator," and establish research fellowships through the University Board of Regents for a comprehensive experimental investigation. This proposal was accepted by Monroe officials and the university, the junior author being appointed fellow, and research assistant on the investigations and studies. A. J. Steffen and Eric Sollid, graduate students in civil engineering, and John Legler, a chemistry student, were named assistants. The work, which covered a 10-month period, was supervised by the senior author and Carl H. Nordell of the Lakeside Engineering Corporation. Messrs. Palmer and Beck, Engineer of Plant Operation (North Side, Chicago) and Principal Sanitary Chemist respectively of the Chicago Sanitary District, rendered valuable suggestions in connection with the studies.

1—Ass't. Professor Hydraulic and Sanitary Engineering.
2—Research Ass't. in Hydraulic and Sanitary Engineering.

Installation and Description of Aerator

The concrete tank used is 24 feet square in plan with a side water depth of 9.0 feet and a hopper bottom with

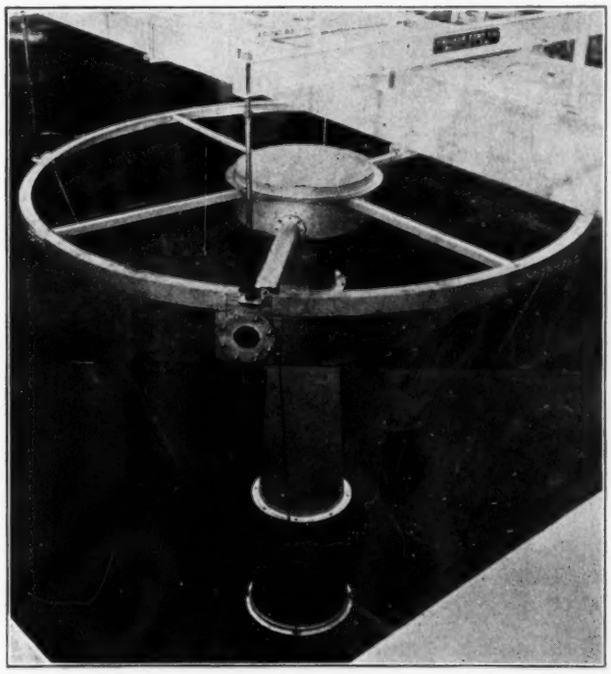


Fig. 1—Splash Plate Supporting Ring and Draft Tube Suspended in Aeration Tank. Around the Tube Throat, at Center, Is Seen the Launder and the Effluent Pipe Connected Thereto. See Also Fig. 5.

Fig. 2—Splash Plate and Diffuser Cone Suspended from Beams. Illustration Pictures Proper Elevation of Mixed Liquor Surface. Note Weirs Between the Curved Figure and Diffuser Cone at Center.

side slopes of about 35 degrees to a depth of 7.0 feet joining a 4-foot square hopper base. There is available a total depth of 14 feet of sewage more or less depending upon the setting of the aerator. The total capacity of the tank is about 45,000 gallons. The new aerator was suspended from the concrete beam designed to support Simplex aerator units with which the other six tanks are equipped.

The following is a description of the Chicago Aerator:

A 12-foot circular supporting steel ring is suspended from beams across the top of the tank. This ring is used to support primarily a central conical steel draft tube 36 inches in diameter at the base and 18 inches at the throat, which extends from about 12 inches above the tank bottom to about 6 inches below the sewage surface elevation. Above the throat there is a slight flare in the tube to a point 3 inches above the normal sewage surface. (See Figs. 1, 2 and 5.) Surrounding this flare, a water tight splash plate is bolted together and supported also by the circular ring mentioned above. This splash plate is divided into 12 sections by low dividing vanes or fins, 5 inches in height. In plan these fins extend radically for a short distance and then become tangent to an arc extending to the edge of the splash plate (Fig. 2 and 5). At the point where the fins become tangent to the arc, one inch angle weirs are brazed to the splash plate between all fins. The draft tube and splash plate always remain fixed in position except for a vertical adjustment of the entire unit.

The sewage lifting device is a three vane weedless type propeller which is keyed to a shaft and direct connected through a flexible coupling to a two speed (870 and 700 RPM) induction motor above. The shaft extends downward to and into an inverted diffuser cone that remains stationary except for adjustment in elevation (Fig. 5). The propeller shaft extends from the motor through the diffuser cone to the propeller which is centered in the throat of the draft tube at an elevation some 12 in. below the sewage level. The diffuser cone (Fig. 3) flares from shaft diameter at the bottom to 24 inches at the top and is about 15 inches deep. This cone has 8 deflecting fins brazed to it similar to the fins on the splash plate so placed as to direct the sewage outward but in a direction opposite to that of propeller rotation.

Operation of Aerator

Sewage and return activated sludge can be conducted to the tank in any desired manner. The propeller lifts the tank contents up through the draft tube and discharges against the diffuser cone which deflect the sludge-sewage mixture outward and downward to the splash plate. It passed over the little weirs where numerous hydraulic jumps are produced (Fig. 4) and thence to the surface of the aerated mixture. The splash plate, because of its novel design, causes the entire contents of the tank to take on a rotary counter-clockwise motion, which is opposite to the direction of rotation of the propeller. Pronounced agitation and turbulence of the mixture is thus obtained and the result is a rapid effective oxygenation of the mixture, this fact being thoroughly demonstrated by operating results.

Combination Unit of Aerator and Clarifier in One Tank

The Chicago Pump Co. felt that a demand is likely to come from industries and small municipalities for a unit that could provide aeration for the activated sludge process and settle the floc without an additional clarification unit being required. The complete plant would then consist of the combination unit, a sludge pit for wasting of excess sludge and a digester or sludge drying equipment. Accordingly the aerator described above was modified as follows:

Without altering the aeration mechanism, the equivalent of a final settling tank without mechanism was installed below the splash plate (Fig. 5). This settling tank consisted of two circular sheet metal baffle walls concentric with the draft tube. The inside wall (12 ft. diam. cylinder) was suspended from the circular ring supporting the splash plate, being made integral and water tight with the splash plate. This cylinder, open at

Fig. 3—Bearing Leg with Adjustable Diffuser Cone

SECTIONAL VIEW OF CHICAGO COMBINATION AERATOR AND CLARIFIER

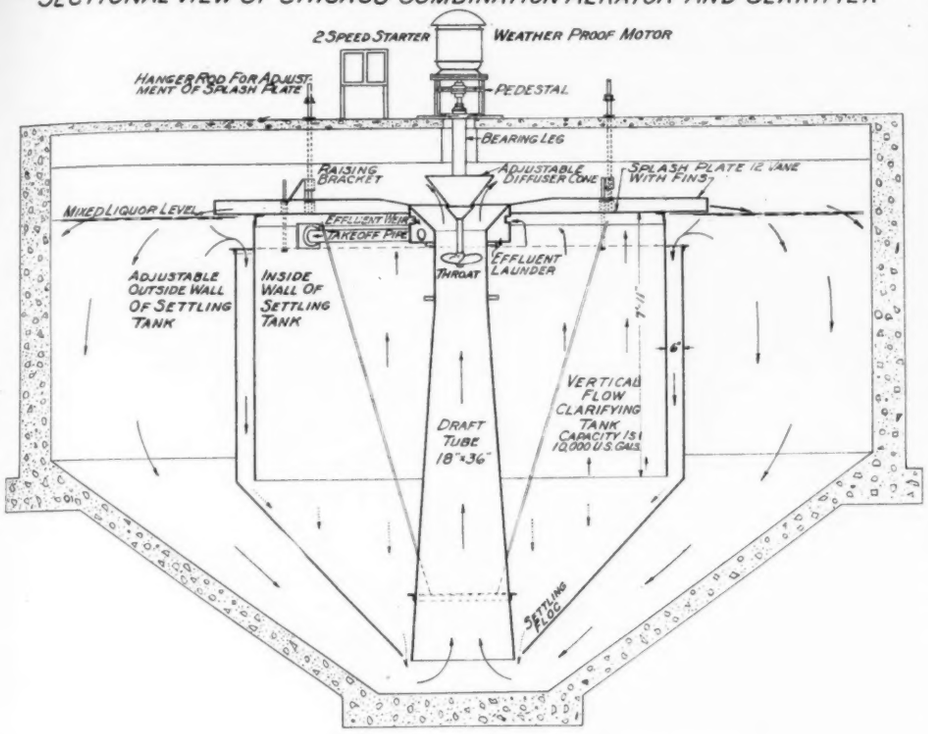


Fig. 5—Sectional Drawing of Chicago Aerator-Clarifier

the bottom, extended down into the tank contents for 8 feet. Surrounding the interior cylinder was another with a six-inch larger radius. This outside wall was suspended from another circular ring fastened to a special steel bracket by adjustable bolts so that the top of this cylinder wall terminated about 12 inches below the sewage surface. The annular space between the inside and outside cylinders was open to the sewage for downward flow. The vertical wall of the outside cylinder extended into the sewage to a point just below the bottom of the inside cylinder wall. At this point an inverted conical sheet metal bottom was fastened to it and carried down at a slope of 47½ degrees to the bottom of the draft tube. An annular space of only 2 inches existed between the outside of the draft tube and the bottom of the inverted cone so that the activated sludge floc could settle out of this settling tank portion of the aerator. It is believed the movement produced as the sewage enters the up-draft tube has a beneficial effect in helping to pull the settling floc through the opening and into the rising sewage sludge mixture. Four vertical baffles about 6 feet long were placed radially between the outside and inside cylinder walls to prevent the rotary motion of the mixed liquor in the concrete tank from being transferred to the contents of the settling chamber.

Effluent Launder and Weirs

A circular launder (Fig. 1 and 5) surrounded the throat of the draft tube, and four rectangular weirs, each 7 inches long, discharged the upward flowing clear supernatant from the settling tank into the effluent launder. A 6-inch W. I. pipe submerged in the mixed liquor was flanged with gaskets to the launder and this pipe conducted the effluent from the launder to a discharge box at the bulkhead in the side of the concrete tank. Where the effluent pipe passed through the circular baffle wall flanges and gaskets were used to make a water tight connection.

Aerator-Clarifier Capacities

Under the operating scheme of the combination unit, the volume of the outside chamber of the concrete aerator tank which was employed for aeration of mixed liquor was about 34,000 gallons and the volume of the central settling (clarifying) chamber was 10,000 gallons. The raw sewage pump, equipped with a suitable bypass valve on the discharge pipe, supplied a rate of flow that could be varied between 15 and 200 gallons per minute.

A special differential fluid gage connected by piping to piezometer connections at the inlet and throat of the draft tube indicated a difference in pressure head of 6.25 inches and 3.5 inches respectively for the high and low speed operation of the propeller. The calculated rate of lifting of sewage through the tube to the aerator head was either 4,750 or 3,730 gallons per minute. By reasonable assumptions as to coefficients and losses, the aerator is believed to operate at between 4,200 and 4,500 gallons per minute at high speed and 3,200 to 3,500 gallons per minute at low speed.

A "Flush-Kleen" sewage pump was installed in a pocket at the end of the grit chamber. Raw sewage was lifted from this pocket through 4 inch piping to a small weir box above one corner of the aeration tank. For treatment, the sewage spilled from this weir box over a calibrated triangular weir into one corner of the aeration tank. Automatic sewage samplers made by the Chicago Pump Co. collected the twenty-four composites of raw sewage and effluent from which the data in this paper was procured. Analyses of samples were made on the grounds in a laboratory set up by the university.

Difficulties With Laboratory Procedures

Two outstanding difficulties were encountered in the field work. These were, the determination of suspended solids in the floc; and, the determination of dissolved oxygen in the mixed liquor. In the first case it was found impossible to use the asbestos mat for these mats would clog immediately in the small sized Gooch crucibles that were available. The procedure utilized was to

Table 1—Nitrogen Conversion by the Chicago-Aerator

DATE	NH_3			NO_3		TOTAL ORGANIC NITROGEN		
	Raw ppm.	Mixed Liquor ppm	Effluent ppm	Raw ppm.	Effluent ppm.	Raw ppm.	Mixed Liquor ppm	Effluent ppm.
Apr 3	16.1	4.7	4.1	.91	.81	21	164	19
4	14.	10.	7.	1.37	3.5	35	167	11.6
18	19.	6.8	3.			21	94	14
22	27.	20.	18.	0.4	6.9	22	131	9.5
29	23.	14.	14.	1.5	3.5	31	134	5.2
May 2	17.	2.3	2.3	4.6	3.0	30	111	8.3
6	23.	10.8	13.	4.0	4.3	20	108	13.3

Table 2—Solids Contents and Sludge Condition (Index)

CHICAGO COMBINATION AERATOR AND CLARIFIER UNIT AT MONROE, WISCONSIN

TOTAL, SETTLEABLE, & SUSPENDED SOLIDS

DATE 1934	DETENTION PERIOD Hrs.	SETTLING RATE Gals/Sq.Ft/Day	TOTAL SOLIDS MIXED LIQUOR p.p.m.	TOTAL SOLIDS RAW p.p.m.	TOTAL SOLIDS EFFLUENT p.p.m.	SETTLEABLE SOLIDS ½ Hr. %	SETTLEABLE SOLIDS 1 Hr. %	SUSPENDED SOLIDS MIXED LIQUOR p.p.m.	SUSPENDED SOLIDS RAW	SUSPENDED SOLIDS EFFLUENT p.p.m.	SUSPENDED SOLIDS REDUCTION %	SLUDGE INDEX
APR. 19-27	8.3	259	2104	1041	686	18	11	1359				133
APR. 3-5	5.5	389	2575	1125	740	23	17	1900				121
APR. 29-30	"	"	2430	1120	590	17	14	1755				100
MAY 1-4	4.2	518	2334	1137	690	19	15	1557				122
JUNE 10	"	"	1630	730	570	55	33	1080	96	12	87	508
AUG. 9-17	"	"	2190	—	—	30	24	1707				176
AUG. 19-22	3.7	582	2935	872	618	54	42	2360				228
MAY 5-8	3.3	650	2133	1020	719	27	23	1213				222
MAY 14-23	2.8	778	2203	743	573	24	18	1663	161	57	65	144
JUNE 14-19	"	"	1510	*667	528	41	27	980	*94	21	78	420
JUNE 20-23	"	"	1520	*665	520	81	68	1030	*170	16	91	787
JUNE 26-27	2.1	1034	1235	—	—	92	85	720				1290

* SETTLED SEWAGE

determine total solids in a sample of the mixed liquor, then filter a portion through paper and determine the total solids in the filtrate. The difference was taken as suspended solids in the mixed liquor.

The following procedure was developed for determining dissolved oxygen in the liquors under all floc conditions. A small pressure filter, with cotton outing flannel as a filter cloth, was successfully used to remove the floc without changing dissolved oxygen content. Later, Mr. Beck suggested the use of a 0.4 N solution of copper sulphate, ten cubic centimeters of which was added to a half gallon bottle, and a small pump submerged in the mixed liquor was employed to lift the liquor into this sample bottle, without the addition of air. The copper sulphate speeded up settling and concentration of the floc. It also probably delays the absorption of the dissolved oxygen created by biologic changes in the sludge. The supernatant was siphoned into 250 c.c. D.O. botles for oxygen determination by the Winkler method, the Rideal-Stewart (permanganate) modification being used frequently to check the results. Standard Methods of Water and Sewage Analysis (A. P. H. A. 1929) were followed in making all of the laboratory tests.

The composite samples collected by Chicago automatic samplers were used for all solids and BOD tests on the raw sewage and the effluent. The total and suspended solids tests and the settleable solids tests on the mixed liquor were run on catch samples taken at eight o'clock each morning. These tests were also made at other times during the day but usually checked the eight o'clock readings. The dissolved oxygen figures shown are averages of the tests run during the hours indicated in the column headings (Table 2). The tests before May 12 give the D.O. one foot below the surface of the liquid in the aeration tank and the tests after that date indicate the D.O. one foot above the bottom of the aeration chamber. It was found, however, that the dissolved oxygen content did not vary more than one or two-tenths of a part at these two points. The D.O. closer to the surface of the mixed liquor was considerably higher than at one foot below the surface so the close agreement between the D.O. one foot below the surface and near the bottom was concluded to be caused by the rapid and efficient circulation of the liquid in the aeration chamber of the tank.

Progress and Results

The studies on the combination unit represent only a portion of the investigations carried on during the research program. This accounts for the presentation of data by dates that are occasionally not consecutive. Furthermore, when any great change in operating conditions was made, sufficient time was permitted for the new sludge conditions to become stabilized before evaluating tests were conducted. The writers have available the complete data by individual days, but for the purpose of this paper it is believed desirable to do nothing more than indicate on summary sheets the averages of results obtained throughout various periods of time. This appears to be a fair way in which to show what may be expected in operation over a period of time.

Nitrogen.—In the early part of the work analyses for ammonia, nitrite, nitrate, and total nitrogen were made (Table I). Only a trace of nitrites could be found in the influent and effluent. Ammonia present in the influent was not completely converted in the aeration tank. Nitrate nitrogen was found whenever tests were made on the effluent. It was believed that the nitrogen tests were not revealing anything of importance and were therefore abandoned in later studies in order to amplify other tests of greater importance.

Sludge Characteristics.—No unusual trouble was encountered in the development of activated sludge. In about four days the floc developed a definite light brown color and the settling rate compared favorably with that elsewhere and Fig. 6 reveals a few of the characteristic settling curves obtained in the various tests. The curves of June 23rd are shown because this run (June 14-23) was the only one in which effluent from the primary settling tank was pumped to the aerator. Indications were that with settled sewage the settling rate of the sludge was not as good as when raw sewage was treated. This may explain the poor sludge index at times when the B.O.D. reductions were exceptionally good. In all tests an attempt was made to try to hold the sludge volume to about 15 to 20 per cent in the mixed liquor after settling for one hour. Found to be impractical this type of control was abandoned in later test runs.

Solids.—Table 2 reveals results obtained from the determination of total settleable and suspended solids. The local water supply carries about 350 to 422 p.p.m. of solids depending on which well is used, and this should be considered in examination of results from the total solids test. A divergence in total solids of the raw sewage is indicated only where settled sewage was

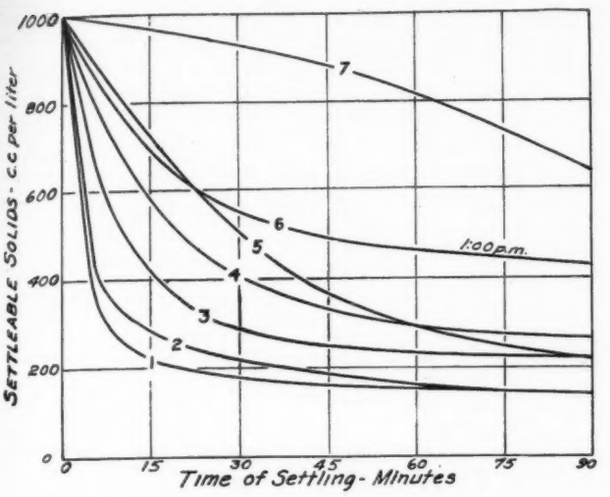
Table 3—Dissolved Oxygen and Oxygen Demand Values

CHICAGO COMBINATION AERATOR AND CLARIFIER UNIT AT MONROE, WISCONSIN

DISSOLVED OXYGEN AND B.O.D. SUMMARY DATA

DATE 1934	FLOW TREATED Gals/day	pH	AERATION PERIOD Hrs.	DISSOLVED OXYGEN 8-9 A.M. p.p.m.	DISSOLVED OXYGEN 2-4 P.M. p.p.m.	SUSPENDED SOLIDS MIXED LIQUOR p.p.m.	SLUDGE INDEX	B.O.D. RAW p.p.m.	B.O.D. EFFL. p.p.m.	B.O.D. ADJUST. EFFL. p.p.m.	B.O.D. REDUCTION %	POPULATION EQUIVALENT BY RAW SEWAGE	POPULATION EQUIVALENT BY EFFLUENT TO CREEK
APR. 19-27	28,800	7.5	28.3	2.2	1.0	1359	133	426	45	38	91	602	54
APR. 3-5	43,200	7.3	18.9	2.0	0.2	1900	124	451	78	69	85	955	144
APR. 29-30	" "	7.3	"	1.1	0.7	1755	100	594	46	55	91	1258	114
MAY 1-4	57,600	7.3	14.2	1.0	0.5	1557	122	563	122	148	74	1590	414
JUNE 10-13	" "	7.3	"	1.8	0.1	1823	508	326	113	113	65	906	317
AUG. 9-17	" "	—	"	0.2	0.1	1707	176	274	25	25	91	773	69
AUG. 19-22	64,800	—	12.6	0.1	0.0	2360	228	343	70	74	79	1090	229
MAY. 5-8	72,000	7.3	11.3	0.6	0.6	1213	222	418	83	83	80	1470	234
MAY. 14-29	86,400	7.4	9.5	1.4	0.8	1663	144	227	32	35	84	960	154
JUNE 14-19	* " "	7.6	"	5.0	1.6	980	420	*180	13	12	93	*760	50
JUNE 20-23	* " "	7.6	"	7.6	3.0	1030	787	*226	15	18	92	*940	76
JUNE 26-27	115,000	7.6	7.1	3.6	0.6	720	1290	204	1105	1109	50	1150	575

* SETTLED SEWAGE



CURVE NUMBER	1	2	3	4	5	6	7
DATE AT 8:00 A.M.	APR. 28	MAY 21	AUG. 15	JUNE 14	JUNE 9	JUNE 23	JUNE 23
SUSPENDED SOL.	1950	1950	1340	820	990	960	960
B.O.D. REDUCTION %	91	82	92	80	77	87	87

NOTE: JUNE 14 & 23 SETTLED RAW SEWAGE TREATED

Fig. 6—Settling Rates of Sludge

used or at times when creek water was being pumped into the raw sewage to obtain a sewage of a lower B.O.D. value for test purposes. It is regretted that, due to investigations on the characteristics and behavior of the sludge, time was not available for making suspended solids determinations on the raw sewage and final effluent during all of the tests. However, the tests that were made indicated a removal of suspended matter varying from 65 to 87 per cent—with most of them nearer the higher figure. The clarity of the effluent during runs when suspended solids tests were not made was about the same as on dates of testing, hence it is believed that the clarifier unit can produce good settling results, provided the rate of settling curves of the sludge (sludge settleability) is favorable. With one exception, when settled sewage was used, the settling rate of the floc was always less than about 55 per cent in one hour, and the settling tank had no difficulty in clarifying the mixed liquor even at the rate of upward flow equivalent to 1,036 gals. per square foot of settling area per day, which was available in the interior clarification chamber of the combination unit.

The sludge index (the volume in cubic centimeters occupied by one gram of sludge after a settling period of 30 minutes) is indicated in Table 2 and these values are in general higher than those obtained in several American plants. There appears to be no agreement between this index and the degree of purification obtained and reduction in suspended solids.

B.O.D. Reduction.—Table 3 contains results obtained when starting with the longest aeration period (28.3 hrs.) and thereafter decreasing to the minimum (7.1 hrs.) by steps. It will be observed that the B.O.D. of the raw sewage was varied for test purposes by diluting the raw sewage and settled sewage with creek water. A pump was installed on the bank of the creek some 300 feet from the calibrated weir box where the creek water was added to the raw sewage in proportion desired.

As a matter of interest, the population equivalent of the raw sewage being treated and the population equivalent in the final effluent to the creek are indicated. In this calculation, it was assumed that 0.17 pounds of 5 day B.O.D. per 24 hours is the per capita daily oxygen requirements of normal domestic sewage. This presentation will give some idea of the magnitude of the test placed on this individual unit. In general, the aerator was required to treat sewage equivalent to a load of 1,000 people. In the shorter aeration periods the flow was varied from 57,600 to 86,400 which approximates what might be expected in a small community of 1,000 persons contributing 60 to 80 gals. of sewage per capita per day.

The last run (June 26-27) is obviously beyond the capacity of the unit and the poorest B.O.D. reductions (50 per cent) were obtained with accompanying high sludge index. A reduction of only 65 per cent was obtained between June 10-13 on a strength of sewage similar to that of Milwaukee, but a high sludge index was obtained. The reduction of suspended solids (Table 2), however, was very satisfactory. In all of the other tests the reduction in B.O.D. lay between 75 and 93 per cent and with proper sludge control the daily tests indicate reductions approaching 90 per cent. With the exception of runs during periods of May 5th to 8th and June 10th to 13th, the higher ratios of suspended solids carried in the aerator (mixed liquor) gave a lower result in B.O.D. reduction. It should be recalled that the experiments during June 14th-23rd were conducted on settled sewage which lowered the suspended solids present in the aerator.

POWER CONSUMPTION

Date	Million Lbs. Sewage Flow per Day	Total Lbs. B.O.D. Reduced/day	Kw. Hrs. Used per Day	Lbs. B.O.D. Reduced per Kw. Hr.	Kw. Hrs. per Million Gals.
Apr. 19-27....	0.24	93.0	110	0.842	3,900
Apr. 3-5.....	0.36	138.0	110	1.50	2,540
Apr. 29-30....	0.36	194.0	110	1.76	2,540
May 1-4.....	0.482	200.0	110	1.82	1,910
June 10-13....	.482	104.0	92	1.13	1,595
Aug. 9-17.....	.482	118.0	92	1.28	1,595
Aug. 19-22....	.540	146.0	90	1.62	1,390
May 5-8.....	.600	200.0	104	1.93	1,445
May 14-29....	.720	138.0	104	1.33	1,205
June 14-19....	.720	120.0	90	1.33	1.050
June 20-23....	.720	150.0	90	1.67	1,050
June 26-27....	.960	97.0	90	1.08	782

Power Consumption.—The above table indicates the results of studies on the power consumed by the aerator as measured at the switchboard.

Conclusions

1. The Chicago Aerator-Clarifier combination unit successfully produced a good activated sludge as substantiated by the characteristics and behavior of the sludge floc and high reductions in biochemical oxygen demand values.

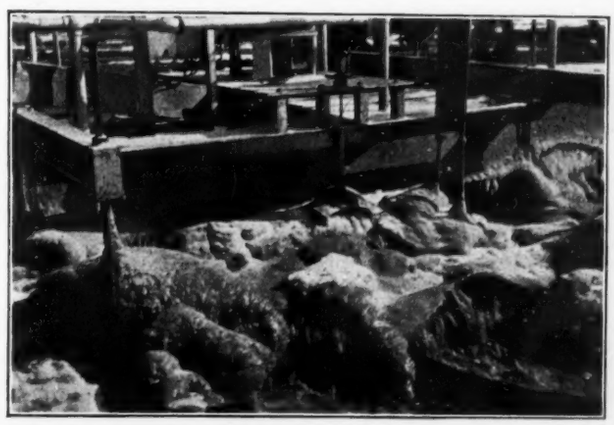


Fig. 7—Aerator Performance During Sub-Zero Weather

2. The combination unit of the capacity and size tested at Monroe, Wis., can be considered as being capable of treating the sewage from a population equivalent of 950 to 1,250.

3. Under the conditions of the tests, the desirable aeration period lies between 9 and 19 hours depending upon the strength of the raw sewage under treatment, 180 to 590 p.p.m. B.O.D. values.

4. Free ammonia was present in the raw sewage, mixed liquor and final effluent. Passage through the aerator unit decreased the ammonia present by 34 to 87 per cent. Nitrates were found in the effluent whenever tests were conducted.

5. The results of the summary data on solids (Table 2) show the effectiveness of the settling chamber. At no time during the period of testing could low B.O.D. reduction be attributed to poor operation of the settling chamber. The sludge apparently never remained for a long period in the settling chamber because the concentration of sludge in the bottom of this chamber was never found to be appreciably greater than that of the mixed liquor.

6. The results indicate that the combination unit, employing the activated sludge process, can produce satisfactory reductions in biochemical oxygen demand and provide sewage treatment which may be termed good to excellent.

7. The Chicago Aerator-Clarifier required an electric power input, at the switchboard, which varied between 90 and 110 KW. hrs. per 24 hour day while aerating sewage at a recirculation rate of about 4,200 gallons per minute. In general the tests indicate that for each KW. hr. required at the switchboard, a reduction of 1.5 pounds of biochemical oxygen demand was obtained.

Discussion

1. While the results of tests indicate a satisfactory treatment, using either raw or settled sewage, the quality of the sludge when treating settled raw sewage never appeared to be that of a desirable sludge. It seemed to us that we were always afraid of sludge going over into the effluent. This is perhaps unusual because previous experience at the municipal plant had indicated that the treatment of the strong raw sewage without preliminary settling might prove more difficult than treating settled sewage. The reverse, however, was the case during our studies at Monroe.

2. Operation of the aerator is not stopped or even seriously affected by the formation of ice during periods of severe cold weather, as indicated in Fig. 7. When this picture was taken, the aerator had been operating over a week in sub-zero weather and the operators were careful that no ice was dislodged during the period. No interference with the effectiveness of aeration could be detected. Further, the ice was easily removed except at the four adjustable hanger rods, where a 5-inch diameter cylinder of ice was built up.

3. Experiments were made with two types of propellers and several changes in throat size and it is believed further hydraulic studies would make possible certain changes in design that would probably lower the power consumption without materially affecting the rate of aeration of the sewage.

4. Obviously any demonstration of this nature, where but one tank is used, is likely to allow some short circuiting of raw sewage to the effluent box. Therefore it is reasonable to expect, when several aerators are used in series (with or without the clarifier unit) that a more effective and dependable treatment would ensue.

5. In the experimental work, the aerator was operated at maximum speed at all times. However, from the results of certain tests which the writers plan to discuss in another paper, we are positive that in many cases where the night flow is low, it would be not only possible, but a distinct advantage to operate the aerator at a slower speed during the night. The rate of consumption of oxygen by the sludge is materially decreased during the night and it is obviously desirable practice to lower operating costs by reducing power input wherever conditions permit such flexibility of operation.

Acknowledgment.—The above paper was read before the Central States Sewage Works Association, Sept., 1934, at Fond du Lac, Wis.

▼

Harry F. Ferguson Dies
A Leading State Sanitary Engineer

H. F. Ferguson
(A recent snapshot)

Harry F. Ferguson, Secretary of the Sanitary Water Board of Illinois and Chief Engineer of the Illinois State Department of Health, died in his 45th year, after a brief illness, while in a Chicago hospital on January 16th. Born in Adams, Mass. (1889), he was graduated by the Massachusetts Institute of Technology in 1912 as one of its earliest Sanitary Engineer graduates. He accepted a position with the Illinois State Water Survey in the same year. From 1917 to 1919 he did World War service as lieutenant in the Engineers Corps in the Water Supply Division in France. Returning to the State Water Survey he resigned to accept the position of Principal Assistant Engineer with the Illinois State Department of Health and shortly thereafter became Chief Engineer in 1920 after the resignation of Paul Hansen. In 1924 he was made Trustee of the Springfield Sanitary District and took an important part in the design and construction of the local Sewage Treatment Works.

Mr. Ferguson was a member of numerous technical societies and associations, having served as president of the Illinois Society of Engineers, Illinois Academy of Science, Central States Sewage Works Association, Illinois Association of Sanitary Engineers and the Conference of State Sanitary Engineers. He was Fellow of the American Public Health Association and member of the American Society Civil Engineers, American Chemical Society, and was a Legionnaire.

Mr. Ferguson, of basically a public spirited nature, became a highly valuable public servant to the State of his adoption, was instrumental in getting the required legislation on which was built the Illinois Sanitary Water Board, and the strengthening of state wide sanitation. He was intolerant of political intrusion and inefficiency in his own organization or that of municipal employees operating plants which fell under supervision of his office. As an author of ability, he was a valued and frequent contributor to WATER WORKS AND SEWERAGE.

Mr. Ferguson was highly praised by municipal authorities for his policies, fair dealings and his ability in directing the state's Sanitary Engineering Division. He is survived by his widow, Zelda Hanson Ferguson, and a daughter, 9 years old.

THE PROPOSED CONEY ISLAND SEWAGE TREATMENT WORKS OF NEW YORK CITY

A Modern Chemical Treatment Plant of 35 M. G. D. Capacity

By RICHARD H. GOULD

Engineer in Charge, Sewage Disposal and Intercepting Sewers, New York City

Richard H. Gould

SEWAGE treatment, facilities in New York City, prior to the formation of the Department of Sanitation in 1929, had been provided to treat about ten per cent of the city's sewage in some fifteen plants, but this, as a rule, only to the extent of fine screening, with chlorination in a few cases. The Wards Island Project for intercepting sewers and an activated sludge plant of 180 M.G.D., for one-fifth of the flow from the city was placed under construction in 1931, but further construction has been held up because of lack of funds. Applications have been made to the Federal Government for a loan and grant in the amount of $25,245,600 for the completion of the Wards Island Project and also in the amount of $1,867,300 for the first part of the Coney Island Sewage Treatment Project. An allocation of funds has been secured for this latter project and it is planned to put the work under construction at the earliest practicable moment.

General Description

The Coney Island Sewage Treatment Works, proposed for immediate construction, will constitute the first step in the development of what is known as Project No. 2 in the "General Plans for Sewage Disposal for the City of New York," as developed by the Department of Sanitation. The first step will permit the treatment of the sewage now passing from five existing plants in the Coney Island section of Brooklyn to the waters of Coney Island Creek and Shellbank Creek.

The new plant will be located at an existing site at Avenue Z and Knapp Street in the Borough of Brooklyn, and the immediate area to be connected will be about 1,700 acres. Upon the completion of an additional trunk sewer, an area of about 11,450 acres will become tributary to the works. The present flow is estimated at 15 M.G.D. and the ultimate flow to be expected at the plant in the year 1970 is estimated at 140 million gallons per day. The present plant is to have a nominal capacity of 35 million gallons per day or one-quarter of the ultimate development.

Purpose of Plant

The sewage that is to be connected at once to the new plant is now passed through the W. 29th Street pumping station and four old treatment plants (so badly outgrown that their treatment functions are no longer effective), and discharged into Coney Island Creek and Shellbank Creek. Putrefactive and obnoxious conditions have resulted in these waters. It is interesting to note in passing that three of the older plants mentioned above were built in the years 1886, 1887 and 1892 and operated as chemical precipitation plants under the Powers patents.

The cleaning up of the waters of Coney Island Creek and Shellbank Creek is in itself a vital matter for local residents and to permit the development and proper use of the large Marine Park which is about to be undertaken by the Park Department. Perhaps the most important reason for sewage treatment in the area, however, is the necessity of protecting the great bathing beaches at Coney Island, Brighton Beach, Manhattan Beach and the Rockaway Beaches. Crowds of from 500,000 to 1,000,000 people a day use these beaches and surrounding waters in hot summer weather. It is recognized that the present plant is not the full solution of this beach pollution problem but it does provide for the immediately adjacent area. Additional plants will be built to care for other sources of pollution.

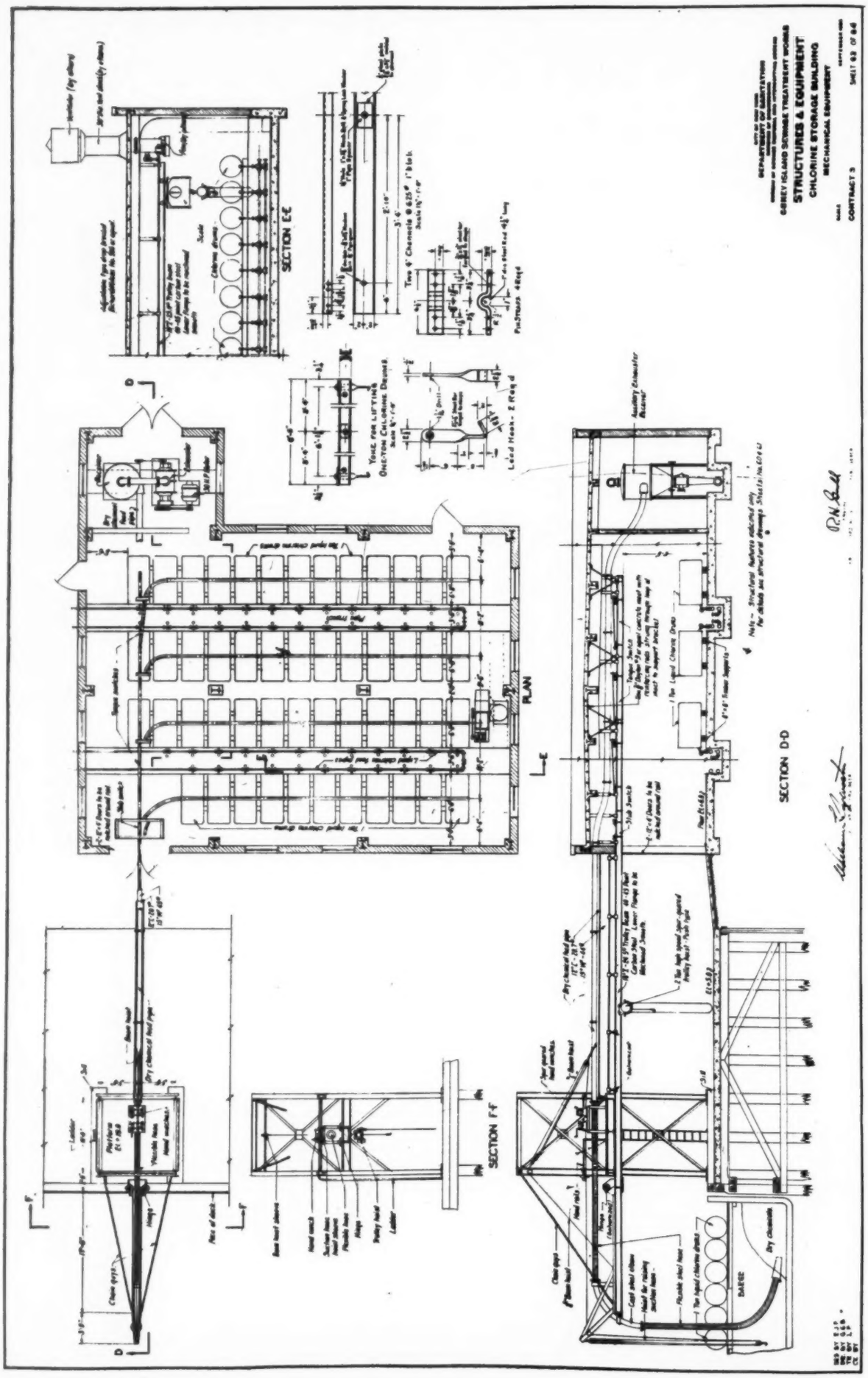
Plant Effluent

The treatment plant site is located on Shellbank Creek, a tidal estuary. There is little dilution available here and it is not considered a suitable location for the discharge of a sewage effluent. It is proposed to discharge the effluent through an outfall line some 8,300 feet long to an outlet structure and diffusion pipes bordering on the main channel in Rockaway Inlet leading to Jamaica Bay. The tidal prism of Jamaica Bay, amounting to some two and one-third billion cubic feet, passes the proposed point of outlet on each stage of the tide. The trend of the tidal currents, as determined by float tests carried out in the past, and as indicated by the formation of the channels shown on Government charts, is toward the open ocean rather than toward the not distant bathing beaches of Coney Island, Brighton and Manhattan.

Treatment Proposed

The sewage to be treated is a domestic sewage containing very little trade waste. It does, however, contain unusually high amounts of sulphates and chlorides.

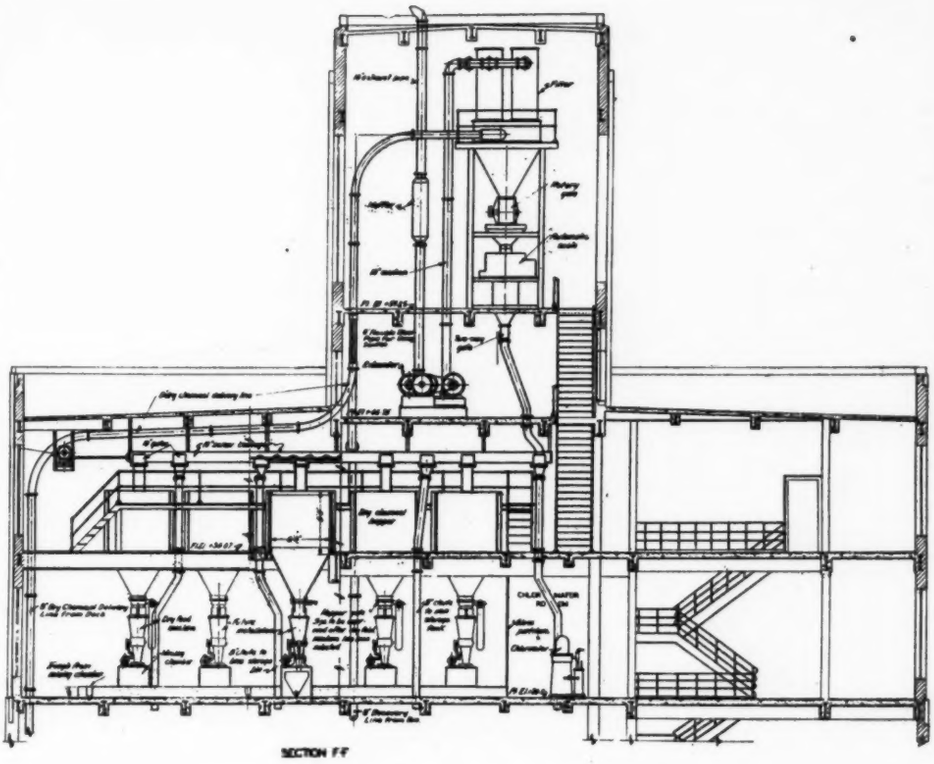
A consideration of the conditions surrounding the proposed point of discharge of the sewage indicates that during the summer months sewage should be treated to a point where the visible suspended solids are removed and that it be reasonably free from bacterial pollution. The very large dilution available at this point and its nearness to the open ocean would seem to insure that ample dissolved oxygen will be present in the waters for a long time to come, even though a high B.O.D. removal



Chlorine Storage and Service Building to Handle One-Ton Containers—Coney Island, New York, Sewage Treatment Works

is not effected. During the winter months there is no apparent necessity for carrying treatment beyond that required to avoid sludge deposits in the neighborhood or, in other words, the removal of most of the settleable solids. It is felt that the conditions at the outfall would be met by either the activated sludge process, or chemical precipitation and chlorination during the summer time and by plain sedimentation during the remaining months.

The site available is quite limited for an activated sludge plant and is badly cut up by the intersecting streets. The present power rates are high in the existing stations operated in this section. These points handicap the adoption of the activated sludge process. It is possible to secure water delivery of chemicals at the site and produce the requisite results from a treatment standpoint at a somewhat lower capital investment with the chemical precipitation process than with the activated sludge process. The chemical plant is better adapted to the available site. These considerations have led to the adoption of the chemical precipitation process for use during the bathing season with the proposed operation of the plant to provide plain sedimentation during the winter months.



Section Through Chemical Storage and Feeder Building

The plant is so laid out that in case a degree of treatment is required in the future beyond that furnished by chemical treatment and sedimentation, mechanical filters of a suitable type can be added. If the present appropriation permits it is the intention to install such filters now.

It is noteworthy that the chemical process using iron salts and lime as precipitants that was used in this area some forty-six years ago and, if we can believe old reports, with somewhat less than perfect results, is to be adopted again. In the elapsed time much has been learned about the use of chemicals and about the development of flocs and precipitation. Perhaps the most important advance is our greater knowledge and added facilities for adequate disposal of the extra volume of sludge.

Sludge Disposal

The question of sludge disposal is extremely important. The availability of the open ocean makes the disposal of raw sludge by dumping at sea an economical matter under future enlarged conditions. Because of the present relatively small flows and the undesirability of holding raw sludge in the plant longer than two days frequent barge trips would be necessary. Such relatively small loadings on each trip makes the cost of barging to sea higher than other methods that are available.

A comparison of a number of different possibilities has led to the adoption of sludge digestion tanks with the recovery of digestion gases and their utilization in a gas engine-driven generating plant. The electricity so generated will be used in operating the sewage pumps and meeting other power requirements of the station up to the limit of the available gas supply. The deficit in this supply, if any, will be supplemented by the purchase of illuminating gas for the operation of the engines. Experience in Europe and in America have indicated that it may be possible to meet the entire power demands of the works from the digestion gases developed.

The sludge after passing through the digestion tanks will be converted into an odorless and inoffensive condition. It has some fertilizing value and a higher value in its ability to build up the humus content of poor soils. There are large projects being developed by the Park Department in the immediate vicinity where a great deal of land is being reclaimed by the pumpage of sand from the surrounding waters.

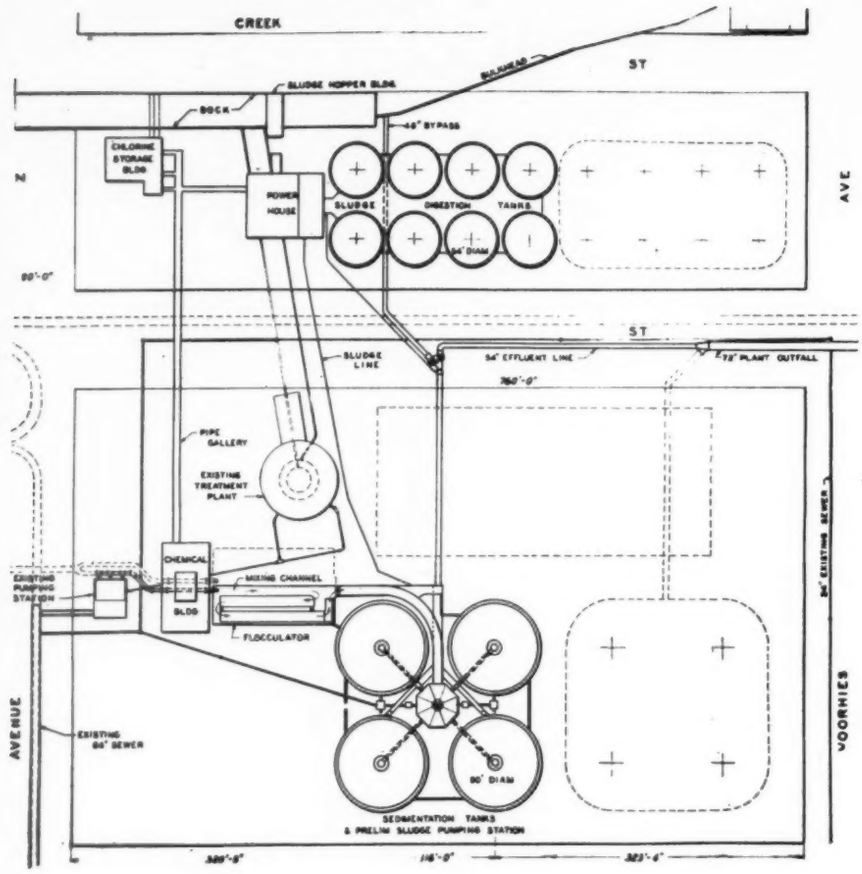
It is felt that digested sludge could be used to excellent advantage in permitting the development of a top soil in this barren waste. Provisions have therefore been made for the installation of a vacuum filter for the filtration of the digested sludge so that this sludge may be utilized on land. It may also be disposed of on land fills or in the rubbish incinerators as required.

The costs of the digestion of sludge and the recovery of gas and sludge with fertilizing value are no higher in the early years of operation than would be the costs of disposal at sea. When the quantities increase the sea disposal becomes cheaper unless some credit be given to the sludge for its value as a fertilizer.

The works are so laid out that sludge may be disposed of by barging raw sludge to sea, by barging digested sludge to sea, by barging digested filter cake to sea, by trucking digested filter cake to serve as a fertilizer on waste land, by trucking digested cake to land fills or to refuse incinerators for final disposal.

Extension of Works

While the works are laid out for a nominal capacity of 35 million gallons per day, it is probable that the Knapp Street trunk sewer will be connected before the flows in



General Plan, Coney Island Sewage Treatment Works

the immediate tributary area will have reached this figure of 35 million gallons per day. On the construction of the Knapp Street sewer large flows now going to the head of Paerdegat Basin will become tributary and it will be necessary at that time to enlarge the present works proposed. This matter has been somewhat discounted in the present installed capacity of sludge filters and digestion tanks.

Principal Features of Plant

Pumping Station—Additional pumps will be installed in the existing Knapp Street pumping station. The pumping plant will consist of six vertical motor-driven pumping units, having a total pumping capacity of 58.0 million gallons daily. The three present pumping units having a total pumping capacity of 16.5 million gallons daily will form part of the above equipment. The six pump motors will total 625 brake horse power of which 225 brake horse power is required by the motors of the three present pumps. The average power load when pumping 35 M.G.D. will be approximately 300 B.H.P.

Settling Tanks—Four settling tanks are to be provided each 90 feet in diameter. They are to be fed from a central distribution manhole and are to be of the radial flow type. A two-hour detention is to be provided at the rated flow of 35 M.G.D. They are to be mechanically cleaned and provided with special effluent screens.

Chemical Handling—Dry chemicals are to be delivered by truck or by barge, at the wharf, in bulk, and from barge to storage bins in the basement of the chemical building by a pneumatic vacuum plant consisting of a 10-inch pipe line from the barge to the vacuum tanks in the tower above the chemical building. The vacuum tanks and exhaustors in the tower over the building are provided with an automatic weighing machine; spouts to storage bins; conveyors to charging hoppers and to spouts; charging hoppers above dry feed machines and automatic proportional feed dry chemical feed machines governed by differential pressures from Venturi meter in the basement.

Charging hoppers are provided having a capacity of one day's supply. Dry feed machines, five in number, have a capacity of 500 lbs. per hour of lime and 1,500 lbs. per hour of ferric sulphate or copperas. Two are to be used for chemicals for processing sludge and three are to be used for chemicals for treatment of sewage.

Water feed to the solution chambers is regulated by proportional feed. The machines are governed by differential pressures from the Venturi meter. The discharge from the machines is to be through open channels in the floor of the operating room to the force main downstream from the Venturi meter. Iron salts may also be applied to the sewer leading to the pump well.

Chlorination—Chlorine is to be delivered by an overhead trolley from barge to storage and through duplicate pipe lines from storage to the evaporators and to the chlorine solution feed machines. The chlorine solution machines are to have a capacity of one ton (maximum) per 24 hours and a minimum rate of 125 lbs. per 24 hours. Four machines are to be provided.

Flocculation—Considerable importance is attached to the flocculating arrangements. Mechanical flocculators are provided for, preceded by rapid mixing devices. Some 250 feet of flocculating channel is provided resulting in a flocculating period of about 11.5 minutes.

Digestion Tanks—Eight digestion tanks are to be built. Each tank is about 55 feet in diameter with an average depth of 28 feet. A total capacity of about 478,000 cubic feet is provided. Each tank is provided with a gas holder type of cover, giving a total gas storage capacity of some 200,000 cubic feet. The tanks are provided with heating coils for hot water circulation which will be largely that used in the cooling systems of the gas engines and derived from exhaust gases.

Sludge Filter—A single vacuum filter is to be installed with a filter surface of 570 square feet. This will be large enough for the flows to be expected in the immediate future. Further extensions will be dependent on the uses to which the filter cake can be put as developed by operating conditions.

Power Plant—The power plant will include three gas-engine-driven electric generating units with switchboards complete. Each generating unit will consist of a 300 B.H.P. gas engine direct-connected to a 200 KW alternating current generator with direct-connected exciter and a heat exchanger interposed in the exhaust from the engine, for recovery of heat from the exhaust gases.

Outfall—The outfall will consist of some 8,300 feet of 72-inch concrete pressure conduit laid partly on land and partly under the waters of Rockaway Inlet. It will

terminate in an outlet chamber provided with relief gates and from which lead cast iron diffusion pipes. Only part of the diffusion pipes will be installed at the start. Some eighteen nozzles will distribute the effluent into the waters of the Rockaway Inlet channel.

Wharf—A wharf will be provided on Shellbank Creek at which chemicals can be received and sludge removed in barges. Elevated storage hoppers are provided on the wharf from which sludge cake from the vacuum filters can be loaded on trucks for disposal on land or to barges for disposal elsewhere. Provisions are also made to dispose of liquid sludge, either in the raw or digested state.

Cost Estimates

It is proposed to construct the works under seven contracts, the cost of which, including engineering, is estimated as follows:

Contract 1—Plant Outfall	$ 505,000
Contract 2—Wharf, Bulkheads & Fill	101,000
Contract 3—Structures & Equipment	1,072,000
Contract 4—Heating & Ventilating	23,000
Contract 5—Plumbing	7,000
Contract 6—Electrical	55,000
Contract 7—Force Main	60,000
Total	$1,823,000

General

The work on the Coney Island Project is being carried out by the Department of Sanitation under the general direction of Thomas W. Hammond, Commissioner of Sanitation. Walter D. Binger is the Deputy Commissioner in charge of engineering and is in immediate charge of the work. The writer is in charge of the Intercepting Sewers and Sewage Disposal for the department and William L. Sylvester is the Designing Engineer. The trunk sewers leading to the plant have been built or are under construction by the Borough President of Brooklyn with Arthur J. Griffin as Chief Engineer of Sewers.

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Keeping Lime Solution Lines Clean

To retard building up of incrustation and deposits, which choke pipe lines conveying lime suspension, the following has been found very helpful at the Richmond, Va., Filter Plant. A program clock at 4 hour intervals opens and closes a flushing valve connected into the line at the inlet end. The line is thereby automatically scoured free of the loosely deposited carbonate and hydrate 6 times daily.

If a scale gradually builds up which the Richmond scheme of water scour will not remove, chlorine water from a chlorinator can be run through for the required period to dissolve or loosen the scale. Chlorine water applied to lime carbonate reacts to produce hypochlorous acid, carbon dioxide and calcium chloride as indicated by the reaction.

$$CaCo_3 + H_2O + 4\,Cl = 2\,HO\,Cl + CaCl_2 + CO_2$$

Pouring chlorine water slowly through a column of ground limestone or marble will demonstrate the reaction and is a well known method of preparing hypochlorous acid. The solution resulting, because of the weakness of the hypochlorous acid produced, has a pH of 8.0 to 8.2.

After the carbonate is all converted, chlorine water will naturally attack metallic solution lines. Lines of rubber hose with jointing made by butting hose ends together inside of a short sleeve of larger size hose, or a short section of pipe, provides a very satisfactory all purpose chemical feed line.—L. H. E.

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Water Supply and Treatment (A Review)

"Water Supply and Treatment," by Charles P. Hoover, Columbus, Ohio, and published by the National Lime Association, Washington, D. C., presents the subject of water softening for municipalities, boiler feed purposes, ice making, brewing, and other industrial uses—together with methods of analysis. It includes in addition, a discussion of water-supply, its sources, requirements, and methods of treatment. It was written to meet the needs of superintendents of small water plants, non-technical operators, laymen, municipal officials, industrialists, and students. Many of this group are interested in the subjects covered, but are unable to obtain the information they desire except in highly technical treatises, or from popular but likely inaccurate sources.

Titles of the fifteen chapter headings follow: Sources of Water Supply; Methods of Purification; Coagulation and Sedimentation; Filters and Filtration; Disinfection or Sterilization; Tastes and Odors; Prevention of Red Water and Corrosion; Water Softening (including economic aspects); Chemistry of Lime and Soda-ash Process of Water Softening; Softening Water for Municipalities (developments and trends); Recarbonation of Lime Softened Water; Zeolite Process of Water Softening; Treatment of Boiler Feed Water; Treatment of Water for Making Ice, Brewing, and Other Industrial Uses; Methods of Water Analysis, Specifications of Treatment Chemicals and Methods of Testing.

This 143 page book was prepared for the National Lime Association by Chas. P. Hoover, a pioneer in and an outstanding authority on water softening practices. It is better sent out, without cost, to those requesting a copy of Bulletin 211 from the National Lime Association, Washington, D. C.

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Arthur S. Tuttle New President A.S.C.E.

Arthur S. Tuttle, New York State Engineer for PWA, is the new president of the American Society of Civil Engineers.

Mr. Tuttle was born March 26, 1865, at Burlington, Connecticut, and was graduated from New York University. He served in various engineering capacities on the development of the Brooklyn water supply, being connected since with the Board of Estimate and Apportionment of the city of New York of which he rose to the position of Chief Engineer, and later Consulting Engineer.

Since August, 1933, Mr. Tuttle has been New York State Engineer for the PWA and also PWA Resident Project-Engineer on the construction of the Triborough Bridge for New York City.

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N.E.W.W.A. Establishes Employment Bureau

The New England Water Works Association has established an Employment Clearing House. Water Works men who need employment are invited to file their address and qualifications and employers who may need an employee are requested to seek a list of qualified and recommended men from Association headquarters. According to a letter from Miss Adelaide Ullian, in charge of the Association office, Statler Building, Boston, Mass., there is no charge for this service. The coöperation of potential employers is requested to make the plan a success.

DETERMINATION OF RESIDUAL CHLORINE

By R. D. SCOTT

Chief Chemist,
State Department of Health,
Columbus, O.

THE first treatment of an American public supply in September, 1908, the application of bleach at the Boonton New Jersey reservoir supplying Jersey City.[1] Liquid chlorine was first applied to water by Darnell at Fort Meyer, Virginia, in 1910.[2] Ammonia-chlorination was introduced by Race at Ottawa, Canada, in 1915.[3]

The now universally practiced control of chlorination by maintenance of a definite residual was developed and advocated by Wolman and Enslow[4] in 1918, to make control more positive and dependable than was possible by bacterial results alone.

A very complete presentation of the newer developments of water treatment and chlorination may be found in the paper of Wolman, Donaldson and Enslow in the Journal of the American Water Works Association (1930) entitled "Recent Progress in the Art of Water Treatment," [5] and a recent paper by Enslow,[24] brings the subject up to date.

Tests for Residual Chlorine

In testing for residual chlorine starch-iodide solution was naturally first employed. The earliest reference to the production of a color compound by ortho-tolidine and chlorine which has been noted is that by Claus and Richter (Ber. 14, 82, 1881). The ortho-tolidine test was used at Boonton, N. J., and described by Kinnicutt, as noted by Montfort.[6] Kinnicutt recognized that neither starch-iodide, as then employed, nor ortho-tolidine were specific reagents for residual chlorine and that false tests were given by nitrites, manganic manganese and ferric iron. A sulphuric acid solution of O.T. was once used at the suggestion of Phelps. In 1913 Ellms and Hauser[7] recommended the preferred use of a hydrochloric acid solution of O.T. and developed the permanent color standards now in use. Fosberg noted blue colors produced in testing and McCrumb[8] explains that the ortho-tolidine color compound is incidentally a pH indicator, changing from blue around pH_4 to green and then yellow as the pH value is lowered from 4 to 2. Between pH 2 and 1 there is but slight change in the yellow tint or its intensity.

Preparation of Ortho-tolidine Reagent.—No difficulty is found in preparing the reagent by adding 1. gram of the powder directly to 1. liter of 1 in 10 hydrochloric acid solution (by volume), providing 2 or 3 days' time is allowed to effect complete solution. By wetting the O.T. first with 1:1 hydrochlorine acid and grinding in a mortar to a slurry, the solution may be quickly prepared.[25] As shown by Davis and Kelly[9] it is well to keep the stock solution of the reagent in the dark to prevent deterioration to some degree.

Preservation of Standards.—The Manual of the American Water Works Association, 1925, page 186, recommends the addition of mercuric chloride to the standards at the rate of 1. cc. of saturated solution to 100. cc. of standard and states that standards thus preserved, if kept in the dark, remain unchanged for as long as 8 months.

Accuracy of Standards.—The permanent standards of Ellms and Hauser were re-studied by Muer and Hale[10] in 1925 and by Adams and Buswell[21] in 1933. Since differences are seen in the results of these observers and since the shade and depth of color as observed through the sides of the tubes are not the same and do not give the same residual chlorine values as when viewed through their length, it would seem that there is need for further study of permanent standards.

Laboratory supply houses have compounded standards of color-fast dyes or glass color discs for special use in comparator sets employed by observation through the tubes from side to side. The permanent standards of the A.P.H.A. Standard Method can not be so used without appreciable error. For such use in a different compounding of standards is necessary.

Factors Affecting the O. T. Test

Light.—Howard[11] in 1928 recommends that after the addition of O.T. the sample should be protected from direct sunlight, noting errors as great as 70 per cent by such exposure. The writer has noted no marked differences on 5 minute readings but on longer standing considerable fading took place in strong sunlight.

Temperature.—Enslow in discussing a paper by Buswell and Boruff[12] in 1925 recommends warming the water sample to 20 deg. C., if such below that temperature, before adding O. T. because low results would otherwise be noted. Incidentally, the writer has observed that at low temperatures the reading even on prolonged standing were somewhat lower than at 20 degrees.

Time of Reaction.—Using the standard O.T. solution false colors due to nitrites and to ferric iron deepen greatly on prolonged standing. Thus at 20 deg. C. 0.1 p.p.m. nitrite nitrogen simulates 0.015 p.p.m. chlorine in 5 minutes and 0.08 p.p.m. in 30 minutes while 0.1 p.p.m. ferric iron, when added to Columbus tap water, simulated 0.025 p.p.m. chlorine in 5 minutes and 0.05 p.p.m. in 30 minutes.

Enslow[12] states: "To obtain the desired residual in plant operation the chlorine should be increased until the test indicates the desired residual at the expiration of 3 minutes or less after adding the ortho-tolodine."* A temperature of 20 deg. C. is recommended, as noted above. It is unfortunate that the latest (7th) edition of Standard Methods of Water Analysis recommends periods of standing of 30 minutes or longer, as the likelihood that false tests will be recorded is thereby considerably increased.

Elimination of False Ortho-Tolidine Tests

It is possible for a raw water to be free from nitrites while the filtered water may contain rather large amounts, formed from ammonium salts during filtration as shown by Hulbert.[13] Also, as noted in 1930 by Braidech,[14] nitrite nitrogen in tap samples may run as high as 0.15 p.p.m. with only traces in effluent samples. He attributes

*It is necessary to explain that since this recommendation was made ammonia-chlorine treatment has been instituted whereupon the 3 minute contact is not always sufficient and 10 to 15 minutes may be required because of slow action of chloramines present. Using an orthotolidin solution containing 18 per cent acid by volume speeds up the chlorine reaction and hastens color development.—Editor.

the increase to oxidation of ammonia by chlorine through the calalytic action of iron.

It should be noted that nitrites present in a raw water are not necessarily oxidized by chlorination. Free chlorine oxidizes nitrites to nitrates but oxidation takes place showly, if at all, if the chlorine be combined as chloramines or similar compounds which have a low oxidation potential.

Unchlorinated water is most likely to contain iron and manganese principally in the divalent form and thus give little if any false test. Then, due to chlorination, the higher balanced compounds will have been formed and, if present in sufficient amount, will cause a false test not detected by testing the water prior to chlorination.

If an analysis of the chlorinated water is available, and it is known that no more than traces of iron, manganese and nitrites are present, then no concern need be felt as to the soundness of the O.T. test on the recently chlorinated water. If doubt exists the starch-iodide test affords an entirely definite means of deciding whether residual chlorine is actually present. This test is later described and may be very useful.

Elimination of Manganese and Iron Interference

Interference by iron and manganese compounds may be eliminated, and that from nitrites lessened, by precipitation of manganese and iron with caustic alkali in the presence of a magnesium salt using the following procedure which was published in the Journal of the American Water Works Association for May, 1934:[15]

> "Two 100. cc. portions of the water are placed in six inch Nessler jars or other suitable containers. Add to each, 1. cc. of magnesium sulphate solution (20. grams $MgSO4.7H_2O$ in water to 100. cc. volume) and mix. Add 1. cc. of sodium hydroxide solution (roughly a 4.5 Normal solution made by dissolving approximately 19. grams of NaOH in water to 100. cc. volume and checked for strength by titration) and mix well. Centrifuge at 1000. r.p.m. or higher for 3 minutes to compact the precipitate and decant off portions of the clear supernatants into a 100. cc. Nessler jar and add 3. cc. of a specially acidified ortho-tolidine reagent—(100. cc. of standard O.T. reagent to which is added 140. cc. of water and 60. cc. of concentrated hydrochloric acid solution). Read the color after 5 minutes."

Certain brands of chemically pure sodium hydroxide were found to have an appreciable chlorine demand. This should be determined as follows: To 10. cc. of the 4.5 N. sodium hydroxide solution in a 100. cc. Nessler jar add 0.2 cc. of a 100. p.p.m. standardized chlorine solution prepared from calcium hypochlorite. After 30 minutes add 90. cc. of distilled water, 10. cc. of 4.5 Normal HCL and 3. cc. of the modified (acidified) O.T. reagent. If residual chlorine is indicated, the alkali may be considered to have no significant chlorine demand. If more than 0.2 cc. of 100. p.p.m. chlorine solution is required, add a volume sufficient to produce a slight residual in the stock solution of 4.5 N. NaOH and allow to stand over night to allow the slight excess of chlorine to be absorbed, before using.

Lessening Interference Caused by Nitrites and Ferric Iron

Ferric iron in certain waters produces false tests of greater magnitude than has heretofore been accepted. Thus, on adding 0.1 p.p.m. ferric iron (as ferric sulphate) to Scioto river water free from iron, manganese and nitrites a false test equivalent to 0.05 p.p.m. chlorine was recorded with standard ortho-tolidine reagent after 5 minutes.[16]

False tests due to nitrites and ferric iron may be materially reduced in magnitude by the use of a modified (higher acid) O.T. reagent[16] [Standard O.T. solution 50. cc., distilled water 35. cc. and concentrated hydrochloric acid solution 15. cc.]). Add 2 cc. to 100. cc. of sample, readings may be made in 2 or 3 minutes if the temperature is around 20 deg. C. This also holds usually for chloramines because little or no increase in color development after 5 minutes has been observed with chloramine-treated waters and standard O.T. reagent when the water temperature was as much as 20 deg. C. provided nitrites and ferric iron were absent. Comparative results with the standard and modified O.T. reagents are:

	P.P.M. Apparent Chlorine			
	Standard O.T.		Modified O.T.	
Interfering Subst.	5 Min.	15 Min.	5 Min.	15 Min.
1. p.p.m. Ferric Iron.....	0.40	0.35	0.02	0.08
0.5 p.p.m. Nitrite Nitrogen.....	0.08	0.30	0.04	0.04

The modified reagent has the incidental advantage that with waters of high alkalinities, the O.T.-chlorine compound produced is always yellow with no green or blue tint.*

It was found that both nitrite and ferric iron interference could also be decreased, without a proportionate lowering of chlorine readings, by cooling the water before adding the O.T. reagent. At around 12 deg. C. as much as 0.2. p.p.m. nitrite nitrogen or 3. p.p.m. ferric iron, after 5 minutes' standing with the usual O.T. reagent, produces a color no greater than the 0.01 p.p.m. chlorine standard and the apparent residual chlorine values are approximately 75 per cent of those at 20 deg. C. A further gain may be effected by using the modified O.T. reagent (2. cc. per 100. cc. sample). At 12 deg. C. 0.25 p.p.m. nitrite nitrogen or 5. p.p.m. ferric iron produces, after 5 minutes, a color corresponding to no more than 0.01 p.p.m. chlorine, while residual chlorine values with the more acidic reagent are about 85 per cent of those with standard O.T. at 20 deg. C.

Starch-Iodide Test

It was found that neither manganese, iron or nitrites produce any color with starch-iodide unless the sample is more acid than pH4.2. Accordingly, all false tests may be avoided by omitting the acid when using the starch indicator. The solution is prepared as follows:[17] To 5. grams of potato starch add a little water to make a paste, then 1 liter of water containing 10. grams potassium iodide and 4. grams zinc chloride. Boil 10 minutes and let stand. Use the clear supernatant. On adding 5. cc. of the indicator to 100. cc. of water containing 0.1 p.p.m. residual chlorine (either free or chloramine) a blue tint is produced at 20 deg. C. The same color is produced by 0.03 p.p.m. at 5 deg. C. and by 0.02 p.p.m. if the water is cooled to 1. deg. C.

It is observed thereby that lowering temperature increases starch-iodide sensitivity to chlorine but reduces that of ortho-tolidine.

Distinction of Chloramines from Free or Hypochlorite Chlorine

Beseman[18] noted that the pink color of methyl orange in acid solution is destroyed by free chlorine or hypochlorite but not by chloramines. The following procedure[14] may be used to approximate the quantity of each compound present: Determine the alkalinity of the water to methyl orange. Add to another 100. cc. por-

*The more acidic reagent is likewise particularly valuable in testing sewage and other organic solutions for residual chlorine. One cc. of reagent is added to 25 cc. samples.—Ed.

tion 1. cc. of N-10 acid in excess of that required for the alkalinity. Add 0.2 cc. of methyl orange solution. (Dissolve 0.5 gram methyl orange in 1. liter of water. Dilute 6. cc. of this solution to 100. cc. with water.) If the color disappears repeat the addition of methyl orange until it persists for at least 5 minutes.

To another 100. cc. portion of the water add the total volume of methyl orange solution thus required. If the pink color now disappears, add the indicator in 0.2. cc. portions until it persists. Each 1. cc. of methyl orange solution decolorized indicates the presence of approximately 0.1 p.p.m. free chlorine but should preferably be standardized against a known strength chlorinated water.

Comments on Previous Methods Advocated for Overcoming False Tests

Forman[19] after making the *unchlorinated* water sample alkaline, treated it with oxygen to oxidize iron and manganous manganese, determined the apparent chlorine and deducted this from the apparent chlorine of the chlorinated water. Enslow[20] measured the apparent chlorine before and after boiling, taking the difference to be residual chlorine destroyed by heating.

Considerable uncertainty must exist, with these procedures as to the actual reactions taking place; the actual chlorine residuals can only be approximated in either case. In both cases the residual is most likely higher than indicated by the tests employed.

Hydrogen peroxide treatment to eliminate nitrite interference has been suggested by Braidech[14] and by Adams and Buswell,[21] but chlorine residuals are also lessened and may be almost if not entirely eliminated if in low amounts—0.1 p.p.m. or thereabouts.

Zeolite filtration to remove manganese was suggested by Scott[22] but a zeolite filter is difficult to prepare and nitrites are not removed, whereas chlorine may be.

Nitrite interference was lessened by holding the samples in the dark after addition of O.T. according to Hulbert.[13] Although the interference is lessened, tests indicate that it is not eliminated and iron and manganese interference is not decreased. For example, 0.2. p.p.m. nitrite nitrogen gave a 5 minute false test of 0.1 p.p.m. in light and 0.06 p.p.m. in the dark—a reduction of only 0.04 in the false color.

Estimating nitrite interference by removing residual chlorine with sodium thisulphate was suggested by Cox[23] in 1932. It fails, however, because nitrites are also partially reduced by thiosulphate.

Acknowledgment: The above paper, presented before the 14th Annual Ohio Conference on Water Purification on Oct. 2, 1934, is reproduced here by special permission granted the author.—Ed.

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Virginia to Hold Ten District Short Schools for Water Works Operators

Appreciating the importance and value of short schools for Water Works Operators, Virginia authorities have decided to extend such schools into several districts to facilitate ease of attendance and reduce the expense and time required of operators who take the courses offered.

Ten cities, as centers of an equal number of zones, have been chosen for holding these 2-day schools annually. Each has been selected with due consideration to transportation facilities, the grouping of Virginia's 285 water works plants, and to provide the greatest convenience to operators and to encourage attendance.

The nature of courses to be given will be governed by the type of water works facilities predominating in each zone and the classifications of operators registering for the courses. Actual laboratory routine will form a part of every course. Demonstrations and talks by manufacturers' representatives will be made to instruct in maintenance and operation care of valves, hydrants, pumps, rate controllers, meters, gages, chemical feeders, chlorinators and the like.

No fees are expected to be charged operators attending and no examinations will be given in connection with the early schools held, but certificates of attendance will be awarded.

These schools are being held under the auspices of the League of Virginia Municipalities and the Virginia Section of the A. W. W. A., with the State Department of Health and the Virginia Polytechnic Institute cooperating. The first school was recently held at the Salem, Va. Filter Plant.

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Elimination of Initiation Fee of A. W. W. A. Extended

At the recent meeting of the Directors of the American Water Works Association it was voted that cancellation of the customary charge of an initiation fee to new members in the Association be continued until 1936. This fee was cancelled in keeping with the times, and for the period of the depression only. But, new members are desired during 1935 and the continued cancellation of initiation fees for this year was voted to encourage water works men to come in before the customary fee is reinstated.

The membership of the Association as of January 1st was 2,350, indicating a net gain during 1934, as compared with losses in recent years. Prospects indicate that with two new Sections (Virginia and the Southwest, which was formerly Southwest Water Works Association) and improving conditions, many new members will be gained in 1935 and a large number will attend the Cincinnati Convention May 6-10.

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Stuart K. Knox Establishes His Own Office

Stuart K. Knox, after many years a co-partner in the firm of Nicholas S. Hill, Jr., announces his withdrawal to establish his own private consulting practice with offices at 25 Warfield Street, Montclair, N. J., and 11 Broadway, New York City.

MEETING OF N. Y. STATE SEWAGE WORKS ASSOCIATION

Modern Laboratory at a Modern Plant (Shades Valley) Birmingham, Ala.

ON January 15th, the largest American sewage works association—the New York State Sewage Works Association—held its record-setting meeting in New York City. This seventh annual meeting of the Association was attended by upwards of 250—the official registration being 212.

Considering the fact that this association holds three meetings* each year, such a large attendance is the more impressive. It is significant possibly of returning of confidence and better times, that meetings of Water Works and Sewerage Associations have been increasing markedly in attendance during the year past. Particularly in sewerage and sewage treatment has there been an awakening of interest and forging ahead with new work in this relatively less developed field of the two.

Trends in Sewage Treatment

At the luncheon session, Professor Charles Gilman Hyde, presented **"Some Comments on Sewage Treatment Problems and Trends"** in which he pointed to the fact that the changing character of sewages, due to industrial wastes, oils, etc., demanded more consideration and recognition in future planning for treatment. He referred to the problem of industrial wastes in sewers and the increasing demand of industrialists for use of the municipal system—for example, pulped cannery-wastes discharged by flushing into sewers having doubled the requirement of treatment facilities at an activated sludge plant in California. The thought of grinding garbage and its disposal by dumping into sewers was to his mind very questionable when considering practical aspects and costs—to wit: the effect of canning-wastes. The comminution or pulping of screenings and return to the sewage seemed to possess merit, however, in simplification of their disposal. Professor Hyde pointed to the advances in sewage solids dewatering on vacuum filters and incineration; the increasing use of detritors in grit removal; the revolving distributor for sprinkling filters; the use of sludge gas for power production; screenings comminution or incineration, such as was the pioneering Los Angeles development, involving incineration of the 70 per cent moisture cake from rough and fine screenings taken from 130 m.g.d. sewage flows—the largest plant of its kind in the world.

Referring to the growing necessity of increasing attention to preliminary treatment of sewages, Professor Hyde pointed to the need for a more effective removal of greases and oils, so deadly to activated sludge processes. He spoke of improved design of settling units—shallow tanks being more effective than deeper ones, provided surface wind action was not a problem. After all, he said, efficient preliminary treatment was conducive to distinct economies in secondary treatment and deserved primary attention. Chemical treatment alone, or in preparation of the sewage for secondary treatment, offered great possibilities and would fit into many places. Chemical precipitation with chlorination would meet rather exacting requirements, even though considered to be an intermediate process. It would require careful control, but was capable of being made effective in coping with changing qualities and volumes of sewage and industrial wastes.

In sludge handling, Professor Hyde referred to the soundness of the principle and greater interest in stage digestion; the use of sludge pumps of smaller capacities and more positive in action; the concentration of sludges to reduce water input to digestors; sludge dewatering and incineration. Los Angeles County Sanitation District, he said, had gone so far as to install four stage digestion. At some points sludge cake was being prepared as a better and more desirable material for land application by the simple expedient of putting it through a disintegrator to granulate it.

At Pasadena odor destruction by burning the sludge dryer gases (perfected at the Univ. of Calif.) had been a recent development.

Kenneth Allen Award to Stilson

For this paper **"The Disposal of Sewage Solids by Incineration"**—A. E. STILSON, President and Chief Engineer, Morse-Boulger Incinerator Corporation, New York City, received the Kenneth Allen Memorial Award for the best technical paper presented before the association during the year. Mr. Stilson's paper dealt with the basic principles of combustion engineering, and requirements involved in the successful incineration of organic materials with especial reference to sewage solids.

W. D. Binger Addresses Joint Dinner

The annual joint dinner of the Association with the Sanitary Engineering Division of the American Society of Civil Engineers, was well attended.

H. E. Miller told of the employment of 3,000 unem-

*1935 meetings to be at Poughkeepsie, N. Y., May 24-25—Fall meeting at Schenectady, N. Y., Oct. 4-5, will be held jointly with the New England Sewage Works Association.

Alden E. Stilson, President, Morse Boulger Company, New York City, Recipient of Kenneth Allen Memorial Award

ployed engineers by the U. S. P. H. Service on its rural privy building program and 1,200 engineers on drainage projects.

The principal speaker of the evening, Walter D. Binger, Engineering Commissioner, New York's Department of Sanitation, reviewed the plans of the department in providing better treatment of New York's sewage and disposal of garbage. The first sewage project since his appointment had been the Coney Island plant involving chemical precipitation and described elsewhere in this issue by R. H. Gould. He said that sewage had probably been neglected because it "moved itself," whereas, garbage was found to be a more serious and more graft laden problem when taken over. New York was now designing its own incinerators and recent developments made it necessary to design these units as steam generating plants to fit into a proposed power system. The earlier scheme was to build for steam production, which had been assured a market by contract with the New York Steam Corporation to yield an income of $250,000 annually. Twenty-two steam generating high temperature incinerators to burn 70 parts rubbish and 30 parts garbage had already been projected in the new power scheme. Mr. Binger, engineer with an eminent record of achievement in the construction field, admitted that none of the present New York City administration looked for re-election or re-appointment and they were going ahead free of political impediments and doing what seemed best for the community in their eyes.

Reports and Resolutions

The report of the Committee on Sewage Research was presented by CHAS. AGAR of the New York Department of Health. He reported on studies made at Lyons, N. Y., involving odor control, in which chlorine applied to the raw sewage ahead of the Imhoff tanks had proven the most effective and economical procedure. Application to the effluent in the filter dosing tanks had not been as effective or as economical as had pre-chlorination. At Liberty, N. Y., chemical precipitation studies had been made on a plant scale. Chlorine, copperas and lime had proved the most efficient and economical chemicals employed. The results had justified further consideration of the scheme, as a means of summer relief from overloaded stream conditions, and its probable adoption in 1935.

A. F. DAPPERT, reporting for the Special Committee on Rating of Sewage Treatment Works, submitted a plan of rating which was accepted. It was voted that an annual award be made by the Association to the operator of the plant receiving the highest rating.

The Association later voted to alter its constitution to allow the establishment of Branch Conferences for several sections of the state, thus making it possible for more sewage plant operators to attend group meetings held closer to their homes.

Resolutions were passed lamenting the passing of two members, George W. Fuller and A. W. Evans during the year. Another resolution commended the recent report of the New York State Planning Board which recommended extension of measures and works to control and eliminate stream pollution.

New Officers

The following officers were named for the ensuing year:

President—Morris M. Cohn, Sanitary Engineer, Schenectady, N. Y.

Vice-Pres.—Robert C. Wheeler, Cons. Engr., Albany, N. Y.

Sec'y.-Treas.—A. S. Bedell, State Department Health, Albany, N. Y.

Directors—Chas. C. Agar, Thorndike Saville, W. W. Watkins.

Board of Control—E. B. Besselievre (Retiring Pres.); M. M. Cohn (Pres.-elect).

Technical Sessions

(Pres. E. B. Besselievre, presiding.)

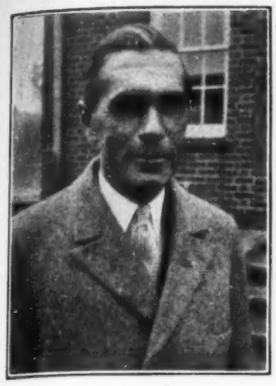
The first, and outstanding, paper on the program was that of H. H. HENDON, Chief Sanitary Engineer, Commission of Jefferson County, Birmingham, Ala., who described **"The Shades Valley Chemical Precipitation Plant at Birmingham, Ala."** (illustrated) and presented operating results and cost data.

Mr. Hendon recounted the recent developments in sewerage at Birmingham, which involved the construction of two plain settling and separate digestion plants and the third and newest, which employs chemical precipitation, chlorination, separate sludge digestion. Important trunk sewers in Birmingham, he said, had been constructed of special light-weight Cast-Iron Sewer Pipe, because the bid price on the project had been only 11 per cent higher than others involving competitive materials, which advantages had more than offset.

Mr. Hendon described the Shades Valley plant, consisting of bar-screens, rapid mixing followed by slow

Professor Chas. Gilman Hyde, Berkeley, Calif.

Morris M. Cohn, Incoming President



E. B. Besselievre, Retiring President

A. S. Bedell, Secretary-Treasurer

motion flocculators from which the coagulated sewage flowed through center feed clarifiers, the effluent going to a small creek. The plant, he said, had been designed to operate in several ways, but the selected scheme involved pre-settling of the sewage in No. 1 clarifier prior to coagulation and secondary settling in No. 2 clarifier. The whole of the sludge settling in No. 2 clarifier from the coagulated sewage was pumped back continuously to the crude sewage for the several advantages accruing—not the least being a 25 per cent saving in chemical costs. Further reasons, were odor control and the better thickening and consolidation of the thinner chemical sludge when settled in combination with the crude solids, both being pumped (5 per cent solids) to the two stage digestion units at a single operation, automatically done by program clock control of the pumps. Interesting, was the observation that the iron precipitation (no lime used) had only increased the sludge volume by 10 per cent. Furthermore, the iron treatment had assisted in producing a supernatant overflow liquor from the second stage digester which contained but 100 p.p.m. suspended solids.

Mr. Hendon reported that the average chemical dosage had been 440 lbs. of ferrous sulphate (copperas) and 70 lbs. of chlorine per m.g. (including that for oxidizing the copperas and chlorinating the sewage) at a cost of $5.40 per m.g.—the chlorine costing $3.00 per cwt. and copperas at $17.50 per ton. The plant effluent had contained less than 10 p.p.m. suspended pin-point floc, with an oxygen demand of less than 20 p.p.m. and frequently as low as 10 p.p.m.

On the stronger sewage at the Ensley works, where an experimental plant had been operated, dosages of 518 lbs. of copperas and 66 pounds of chlorine had consistently produced an effluent containing 18 parts of suspended solids and B.O.D. under 200 p.p.m. The conversion of the existing modern 12 M.G.D. Ensley plant to a chemical plant would cost $212,000 and the estimated operating cost plus fixed charges would be $13.84 per m.g. Based on his experiences, Mr. Hendon's conclusions were that chemical precipitation with chlorination produces results comparable with that from trickling filters or most activated sludge plants. Installation and operation costs had proved to be about 66 per cent of those for activated sludge plants of the same capacity—the chemical plant being capable of operating to provide primary or more complete treatment at will, and without complications.

(Note: Mr. Hendon's paper will be printed in full in the March issue of WATER WORKS AND SEWERAGE.—Editor.)

PROFESSOR CHARLES GILMAN HYDE, University of California, Berkeley, Calif., was very complimentary of Mr. Hendon's paper and the thought given to the design of the Birmingham plants. To him the outstanding features of chemical precipitation were those of flexibility and its utility and economy as a method of seasonal treatment. The value of pre-settling and return of chemical sludge had been particularly interesting to him.

L. H. ENSLOW, in complimenting Mr. Hendon on the

New York State Sewage Works Association, Luncheon Session, New York City, January 15, 1935

"Bill" Wier and "Mike" Singleton of Atlanta, Ga. *Fair, Chase, Cohn (from the rear) Gilcreas* *F. W. Gilcreas and Dr. M. L. Isaacs*

three Birmingham plants, pointed out that the Ensley separate digestion plant was as far as he knew, the cheapest plant of its type and character ever built. Modernly equipped in every respect, it had cost but $11,500 per m.g. capacity ($1.15 per capita) and operating cost had been only $4.02 per m.g. The Birmingham experiences, indicating but a 10 per cent increase in sludge volume during the use of chemical precipitation; the digestibility of the chemical sludge and the high quality of supernatant liquor discharged from the second stage digester (100 p.p.m. suspended solids) were enlightening and impressive. The value of sludge return and presettling, and proper mixing and coagulating equipment had been thoroughly demonstrated. Interestingly, Professor Hyde had designed the San Luis Obispo (Calif.) plant to operate in a like manner—the sludge was to be added to the sewer ahead of the plant to absorb odors and an increment of the non-settleable colloidal materials.

The simplicity and economy of production of chlorinated-copperas was emphasized by Mr. Enslow—the dosages reported, being in terms of the ferrous sulphate crystals with seven molecules of water, which contained but slightly more than 20 per cent iron as compared with about 34 per cent in absolute ferric chloride ($FeCl_3$) were more moderate than they sounded from the figures. He called attention to the growing importance of treatment processes capable of coping with industrial wastes and this situation had focussed more attention on chemical precipitation processes as a preliminary, if not the whole of the treatment, for future consideration. In respect to settling periods with chemical precipitation, Mr. Hendon had found one hour barely sufficient and 2 hours as preferable. It was Mr. Enslow's opinion that chemical and also many activated sludge plants would find effluent straining (coarse filtration) a valuable adjunct and money saving procedure. It would take care of floc passing through the settling tanks during periods of maximum flows (velocities) or deficiency in floc quality—the latter being either unavoidable or perhaps an accepted condition resulting from a program of reduced chemical or air consumption as economy measures.

H. H. Hendon, Sanitary Engineer, Birmingham, Ala.

Wellington Donaldson, Consulting Engineer, New York City

E. T. KILLAM, Consulting Engineer, New York City, pointed out that filtration of the effluents from the Atlanta chemical demonstration plant had at times removed additional and appreciable suspended matter and oxygen demanding matters.

WELLINGTON DONALDSON, Consulting Engineer, New York City, said that earlier a 75 to 80 per cent reduction of B.O.D. by chemical precipitation was considered the top, whereas, now the Birmingham results and others had upped those figures to 90 per cent.

C. C. AGAR, State Department of Health, Albany, N. Y., recounted the experiences with chemical precipitation at Liberty, N. Y., which indicated its feasibility as a seasonal treatment for summer conditions. Chlorine, copperas and lime applied in the order named had proven the most economical chemicals at Liberty.

"Sewage Plant Laboratories" — by WELLINGTON DONALDSON, Fuller and McClintock, Engrs., New York City.

Pointing to the increasing need of laboratories at sewage treatment plants, if operators were to properly evaluate efficiencies and effectively control treatment units, Mr. Donaldson outlined the various features of well equipped laboratories (see header illustration). He presented costs of equipping and maintaining these control stations of such growing importance to plant managers for the purpose of assuring economy and efficiency of operation, and for evolving improved processes or new ones. His discussion dealt particularly with laboratories for plants serving cities of 10,000 to 50,000 population, and therefore having limited personnel. Information on 17 representative modern plants indicated that the cost of equipping an adequate laboratory had been usually less than 1 per cent of the plant cost, and proof of the wisdom of the investment was adequate. A table of data accumulated indicated size, cost, and personnel of various sewage works laboratories.

Mr. Donaldson, who has had considerable experience in equipping laboratories considered $800 for furniture and permanent fixtures; $1,000 for instruments and apparatus; $200 for chemicals as a reasonable sum ($2,000 total) to equip a first class laboratory. Between $300 and $500 would cover the cost of equipment for the simplest laboratory in which the important tests for sludge solids, suspended solids, B.O.D. and residual chlorine could be conducted. He then described important considerations in the arrangement and equipment of laboratories which involved novel and economical features. He had found electric heat suitable for practically all operations where formerly gas had been required. Electric or gas refrigera-

J. L. Barrow (Director) County Sanitary Engineer, White Plains, N. Y.

Frank Roe, Carborundum Company, Niagara Falls, New York

tors were almost essential for low temperature keeping of composited samples required for oxygen demand determinations. As to B.O.D. incubators too little consideration had been given. Apparently, the electric refrigerator, provided with special temperature control elements, had been the most popular with ice-box refrigerators with temperature control as the next and water baths with regulated flow the least. Time saving equipment included chainomatic balances; automatic burettes; vacuum manifold solids filtration through Gooch crucibles; stands and quick diluting arrangements for B.O.D. work; a centrifuge for quick sewage clarification and solids estimates; shallow nickel dishes for quick drying of sludges. The trend, he said was toward better operating control and less waste at the modern works. To this end the laboratory was proving its worth.

T. M. Riddick, N. S. Hill Consulting Engineers, New York City, as a discusser of Mr. Donaldson's paper exhibited several laboratory adjuncts and pieces of homemade equipment, some of which have been described in Water Works and Sewerage, which had been designed by himself and constructed for the Sanitary Engineering Laboratories of New York University.

"Centrifugal Dewatering of Sewage Sludges"—J. S. Pecker, Consulting Engineer, American Centrifugal Corporation, New York City.

Mr. Pecker described a newly developed centrifuge of the bowl type for use in sludge dewatering, which had been tested and demonstrated over a period of months at the Collingswood, N. J., sewage treatment plant. Its capacity being 700 gals. at one filling and operated at 2,000 r.p.m. by a 60 H.P. motor produced 90 cu. ft. of compacted sludge cake, which was thereafter cut from the revolving bowl by knives in a cycle operation with automatic filling of the bowl. The centrifuge had handled all types of sludge (crude, activated, mixed or digested) to turn out between 600 and 1,000 lbs. of dry solids per hour, in the form of a shredded cake containing 55 to 70 per cent moisture. Since it had been more economical to handle sludge of 5 per cent solids content thickening tanks had recently been installed to concentrate the sludge but to date no conditioning chemicals had been employed. Cost data was withheld because premature, but estimates had indicated that the installation cost, would be about 33 per cent of the cost of digestion tanks and sludge beds. Mr. Pecker said that the sludge cake produced would support combustion or could be converted to fertilizer. Mixed crude and activated sludges responded better than had straight activated sludge which was productive of cakes with 75 per cent moisture with markedly reduced yields. In all, 60 test runs had been made since July 1934 and more would be heard from extended developments at the Collingswood plant.

C. E. Keefer, Engineer of Sewage Treatment, Baltimore, Md., recited the Baltimore experiences with centrifugal sludge dewatering, involving a Ter Meer centrifuge in 1924. The most serious drawback had been the very high solids content of the centrifuge effluent with a B.O.D. value of 9,000 p.p.m. The same problem existed with the American centrifuge and needed correction.

In reply to a question, Mr. Pecker said that the American centrifuge effluent had contained from 4,000 to 10,000 p.p.m. suspended solids. The cost of operation had been about $2.50 per ton of dry solids handled.

"Colorimetric Method for Determining Dissolved Oxygen"—by Dr. M. L. Isaacs, Sanitary Engineering Department, Columbia University, New York City.

Dr. Isaacs described a simplified colorimetric test to reveal quickly the dissolved oxygen content of liquids. Amidol, a well known chemical photographic developer produces in alkaline solutions a variety of colors, depending upon the pH of the solution, and the intensity indicated the degree of its oxidation by the dissolved oxygen present. This fact had been made use of in evolving a field and laboratory method for determination of dissolved oxygen, which involved the use of a single solution of citrate of potash and a 2 grain tablet of Amidol such as is supplied ready prepared by the Burrows-Wellcomb Company. The depth of red color produced was compared against permanent standards. The accuracy was satisfactory to within 0.5 p.p.m. D.O. at 8 p.p.m. concentrations, and a greater accuracy

At the Plainfield Treatment Works

Watching the Wheels Go Round, in the Mixing Tanks and Flocculators

The Spray Sludge Drier in Operation

John Downes, Supt., Explaining the Operation of the Plant (Center of Group)

for lower concentrations. Interfering substances were limited to reducing compounds—notably sulphides. The advantages were compactness of equipment and ease of handling, especially desirable in field determinations.

F. W. GILCREAS, Sanitary Chemist, New York State Department of Health, said that he had found the method very satisfactory and thought 2 oz. French square bottles preferable to tubes for making the determinations. He preferred to use 0.26 of a gram of Amidol in soluble capsules rather than the 2 gr. tablets which left an insoluble residue. A full color development required 30 minutes and no fading followed within 2 hours. Temperature and light conditions were of no importance. He had found the test satisfactory in running B.O.D. determinations and it seemed to have distinctive advantages over the cumbersome Winkler method. Turbidities above 100 would interfere when the 2 oz. bottles were used instead of the tubes.

"Features of the Plainfield (N. J.) Sewage Treatment Works"—were set forth by John R. Downes, Supervising Engineer, who showed several reels of moving pictures to illustrate his talk which was preparatory to the visit to the Plainfield plant the day following. He described the chemical precipitation scheme for reducing the loadings on the sprinkling filters and the coagulation and clarification of the effluent from these filters, involving return of the resulting sludge to the incoming sewage and the use of prechlorination and chlorinated copperas as the coagulant in the primary treatment. Mr. Downes described the preparation of digested sludge for the spray drying unit and the operation of this recently completed installation which converts "floated" sludge into a pulverant product useful as fertilizer or as a fuel, at will.

On the following day the Plainfield plant was visited.

[Note: The digest of papers and discussion presented before the Sanitary Engineering Section A. S. C. E. on January 17th—prepared for this issue—must unavoidably be held over for our March issue, because of lack of space.—Editor.]

Association Meetings Scheduled

March 7-8—**Indiana Section, A. W. W. A.** Hotel Antlers, Indianapolis, Ind. Secretary, B. H. Jeup, State Division of Public Health, Indianapolis, Ind.

(Cancellation)—**Kentucky-Tennessee Section, A. W. W. A.** Lexington, Ky. Secretary, F. C. Dugan, State Board of Health, Louisville, Ky.

(The above meeting has been indefinitely postponed since the announcement appearing in our January issue, which gave dates of March 11-13.)

March 20—**New Jersey Water Works Association.** Stacy Trent Hotel, Trenton, N. J. Secretary, W. C. Flanders, Water Department, Newark, N. J.

March 21-22—**New York Section, A. W. W. A.** De Witt-Clinton Hotel, Albany, N. Y. Secretary, R. K. Blanchard, Neptune Meter Co., Rockefeller Center, New York City.

March 21-22—**New Jersey Sewage Works Association.** Stacy Trent Hotel, Trenton, N. J. Secretary, John R. Downes, Bound Brook, N. J. Treasurer, Paul Molitor, Jr., Morristown, N. J.

March 27-29—**Canadian Section, A. W. W. A.** Hotel London, London, Ont. Secretary, A. E. Berry, Ontario Department of Health, Toronto, Ont.

March 28-30—**Florida Section, A. W. W. A.** West Palm Beach, Fla. (Hotel not selected.) Secretary, L. G. Lennert, State Department of Health, Jacksonville, Fla. (The 4th Florida Short Course in Water Treatment is to be held in conjunction with the meeting—A. P. Black, University of Florida, in charge.)

April 2-4—**Southeastern Section, A. W. W. A.** Hotel Thomas Jefferson, Birmingham, Ala. Secretary, W. H. Weir, State Department of Health, Atlanta, Ga.

April 10-11—**Illinois Section, A. W. W. A.** Springfield, Ill. Secretary, A. E. Skinner, Pitometer Company, 5311 Kenmore Ave., Chicago, Ill.

April 11-12—**Four States Section, A. W. W. A.** Atlantic City, N. J. (Headquarters Hotel not selected.) Secretary, C. H. Becker, R. D. Wood Co., 400 Chestnut Street, Philadelphia, Pa.

April 12-13—**Montana Section, A. W. W. A.** Helena, Mont. H. B. Foote, Chief Engineer, State Board of Health, Helena, Mont. (Water Works School to be held April 10-11.)

May 6-10—**Annual Convention of A. W. W. A.** Hotel Netherland Plaza, Cincinnati, Ohio. Secretary, B. C. Little, 29 W. 39th Street, New York City.

Dr. George H. Bigelow Missing

Frank Kiernan, Secretary, Massachusetts Central Health Council, has sent to members of the American Public Health Association, the circular reproduced below.

THE COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC SAFETY
STATE HOUSE, BOSTON

January 4, 1935.

MISSING

DR. GEORGE H. BIGELOW, formerly Commissioner of Public Health of the Commonwealth of Massachusetts, and present Director of the Massachusetts General Hospital, Boston, Mass.

May be a victim of amnesia — DR. GEORGE H. BIGELOW.

DR. GEORGE H. BIGELOW

Description: 6 ft. tall; weighs approximately 175 lbs.; has deep blue eyes; heavy shock of black hair closely cut, slightly gray at the temples. He is of rangy build. When he left his home he wore a soft brown felt hat, a black overcoat with a velvet collar, a brown suit, and tan rubber-soled shoes, and a soft white shirt. He is 44 yrs. of age. He wore a square silver wrist watch with a leather strap, and carried a brown pigskin brief case.

He disappeared December 3, 1934, having left his home in Milton, Mass., for his office in the Moseley Building at the Massachusetts General Hospital, Boston, Mass. He was to appear at 8 P.M., Tuesday night, December 4, 1934, at the Staten Island Hospital to speak, and on Wednesday at the American Society for the Control of Cancer in New York City.

The finger prints of Dr. George H. Bigelow are in the possession of the Department of Public Safety of the Commonwealth of Massachusetts. Hospitals are requested to finger print all amnesia victims unidentified, forwarding the same to Colonel Paul G. Kirk, Commissioner of Public Safety, State House, Boston, Mass.

JOHN F. STOKES, Chief of Detectives.

PAUL G. KIRK, Commissioner of Public Safety, Room 24, State House, Boston, Mass.

Dr. Bigelow was a member of the A. P. H. A. and for many years was State Commissioner of Public Health, and later became Director of the Massachusetts General Hospital.

Since his disappearance on December 3, 1934, there has been no authentic clue as to his whereabouts. Dr. Bigelow's family and many who were privileged to work with him believe he is alive.

Any information concerning Dr. Bigelow should be communicated immediately to your local Police Department which will get in touch with the Massachusetts Department of Public Safety.

Manufacturers of Chlorine Control Apparatus to Codify

The Associated Manufacturers of Chlorine Control Apparatus, has issued under date of January 30, 1935, a notice to all manufacturers of chlorine control apparatus and others concerned, that there will be a meeting at the Chemist Club, 52 East 41st Street, New York, N. Y., on February 26, 1935, 2:00 p. m., to have those *not* members of the Association Manufacturers of Chlorine Control Apparatus, subject to approval of the National Recovery Administration, select from their number, one member for the Code Authority for code of Chlorine Control Apparatus Industry and Trade—approved code Number 536.

EDITORIALS

A Short-Sighted Policy

COMPLAINTS voiced by consulting engineers reveal that the Federal Emergency Relief Administration has created a situation which had resulted in loss of business to established engineering firms with resulting staff reductions and consequent unemployment.

Under regulations of FERA, works involving the requisite of specialized knowledge and training, such as is true of water works and sewerage betterments, have been placed under County Engineers, experienced principally in highway work and surveying. Within FERA and the state affiliate—SERA—there seems to exist an erroneous presumption that as long as municipal types of work be placed in the hands of a civil engineer that is all that is necessary.

To those well versed in modern practices in water works and sewerage, it seems undisputable that FERA should appreciate the value of at least securing project supervisory services by licensed or otherwise qualified engineers who have spent a lifetime specializing in sanitary engineering matters. Certainly, a review of plans with necessary consulting and supervisory services of engineering firms, on a per diem or retainer basis, should prove a safeguard to the quality of work, to the taxpayer's pocketbook; and, likewise, a means of preventing disintegration of established engineering staffs, with consequent added engineer unemployment to be cared for by these same relief agencies.

Better than nothing, trained engineer personnel from consulting offices may be loaned to public works relief agencies to supervise projects. This plan may offer a legal solution to FERA and SERA requirements and thereby prove fair to the employe. The damage to employes who will be unjustly deprived of their legitimate business as a result is, however, a matter of serious consequence.

Before proceeding with the large program of public works betterments for 1935 federal and state relief administrations, which have not made use of qualified specialists as supervisory agents, should take steps to eliminate this short-sighted policy which bids fair to prove very costly in the end.

▼

Engineers and Activated Sludge

MANY consulting engineers and municipal authorities are considerably concerned about the status of the sewage treatment processes which have been or are likely to be, considered by district or federal courts as infringing U. S. patents. There is need for thought, rather than fear, in future planning of sewage treatment and the selection of processes.

Since the decision of the courts which has held Milwaukee and Chicago to be infringing patents on the activated-sludge process, there has been a decided shying away from the process by engineers previously prepared to recommend it to clients. For the same reason municipal officials have been inclined to postpone adoption of the process until the expiration date of all important activated-sludge patents has been reached—November, 1935.

This does not appear warranted in the majority of cases, however, and, especially so when one considers the relatively small license fee being asked by Activated Sludge, Inc., of Chicago, as holders of the patents. Certainly the payment is not onerous in the case of small and medium sized plants, wherein the license fee of 25 cents per capita served will be a very small percentage of the whole cost of the works. After all the first cost of an activated sludge plant (including the fee) is not an important element in small installations and, since no running royalty is asked on gallonage subsequently treated, the more important operating cost which makes up the major expense of activated sludge treatment is not in the least affected by the patent situation. It therefore seems expedient for municipalities to go forward with plans and arrangements for a license when it comes to relatively small capacity projects.

When it comes to projects sufficiently large to involve a considerable licensing expense to the municipality, there is still no real reason for delaying plans and construction on projects designed to make use of any or all of the activated sludge patents, which are to expire before the end of 1935. In most instances, before the plant can be made ready to place in operation this expiration date will have been reached. If not, the plant may be operated as a sedimentation plant until December 1935, during which time the plant may be tuned up and effective digestion of sludge established, pending the time when the more difficult activated sludge has been built up and must be dealt with by the then established digestion process. Further, if it seems desirable in the interim, activated sludge plants are eminently suitable for operation as chemical precipitation plants. Any desired number of the aeration tanks can be employed as excellent mixing and flocculating units handling pre-settled sewage.

From the best opinions of patent attorneys, several municipalities have been informed that no infringement of a process patent can be held to exist until the process is used in fact. If this be correct, and apparently it is, then a municipality may without infringement proceed to construct and tune up a plant designed to employ a patented process so long as it is operated with something short of the patented process until after the patents have expired. Thus a plant may be operated as a plain settling, an air blowing, or a chemical precipitation plant (involving air blowing) to obtain a degree of purification between 40 and 80 per cent, at will, without infringing the activated sludge process.

In some cases the presence of flocculating chemicals in sewages have been primarily the cause of coagulation and effective clarification (without bulking) in which the aerator units serve as efficient and anti-septizing flocculating devices. The arguments of opposing experts in such cases should be interesting reading to those who find it somewhat difficult to define or draw specifications to cover activated sludge when on its best behavior—not to mention "Friday," "Saturday," "Fourth of July" or "Thanksgiving Day" activated sludges.

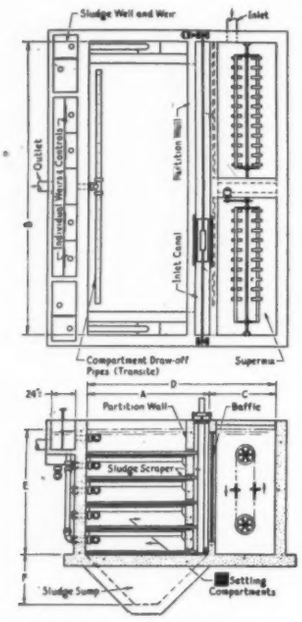
Return to the practical aspects of the existing status of the activated sludge situation, municipalities of small size need not fear the cost of the license fee and should accordingly proceed with their plans construction and operation. The larger municipalities may, according to legal advice, proceed with construction and negotiate with the patent holders for a license on the basis of the remaining life of the patents. Or, failing of a satisfactory agreement, they may complete the plant and operate it, without infringing, in one of several ways to procure the desired degree of purification for the remaining life of the patents.

NEW EQUIPMENT AND LITERATURE

Infilco Super-Settler

Those who attended the recent meeting of the New York Sewage Works Association heard Professor Chas. Gilman Hyde comment on the economic and technical advantages of shallow settling basins over deep ones, the only disadvantage being the greater land area required and the effect of winds in disturbing the shallow restive zone of sedimentation.

As if in answer to these two important objections, the Super-Settler has been perfected by International Filter Company of Chicago. From the illustration, one can see that the Infilco Super-Settler is in effect shallow settling tanks stacked five



Infilco Super-Settler

deep in order to take advantage of shallow settlers and at the same time reduce the area to but 20 per cent of that otherwise required for the same volume of settling capacity, i.e., same period of sedimentation. It is apparent that wind action, if a problem, can only disturb the top settler—i.e., only 20 per cent of its settling capacity.

The Super-Settler is equipped with adequate control devices to procure equitable delivery of influent to each "story," and uniform displacement through each compartment. Equipped with a multiple scraping mechanism, which is removable from and returnable to the settler without taking it out of service, the floors of the shallow chambers are continuously freed of deposited solids which are scraped to sludge hoppers at each end of the settler. Also, in combination with the settler, the Infilco "Supermix" flocculating device is offered to effect a more efficient and economical coagulation.

The basic principles of sedimentation, and the design features of the settler are effectively covered in an illustrated bulletin—"The Super-Settler"—which will be of interest to anyone having to deal with water purification, sewage of industrial waste treatment. Address—International Filter Co., 59 East Van Buren Street, Chicago, Ill.

▼

Crane Double Disc Gate Valves

In a new brochure issued recently by Crane of Chicago, their Double Disc Gate Valves are illustrated. Amongst the 12 points of superior construction listed are the following: The ability to repack stuffing boxes under full pressure with valve open; non rusting brass glands; machined and bolt held stuffing boxes; rugged stems of manganese bronze alloy with strength of steel; brass (dovetailed) disc faces without rivets; disc guides and lugs insure ride to a perfect fit of brass discs against the brass seat rings. These valves (No. 408½) are built to A.W.W.A. specifications in sizes from 2 to 48 inch. In addition, Crane Low Pressure Double Disc Valves are illustrated and described.

For a copy of "Crane Valves for Water Works and Sewerage," write: Crane, 836 Michigan Avenue, Chicago, Ill.

▼

A New Joint for C. I. Pipes

R. D. Wood Company of Philadelphia, Pa., have recently perfected a new mechanical joint for bell and spigot plain end Cast Iron Pipes. Known as the "R.D.W. Ovalseal" joint, it is made up of a light weight malleable C. I. gland (follower ring) bolts and ring gasket of rubber, the latter being oval in form. Bolting up the gland forces the gasket into the bell end (of special design) to make a tight but highly flexible joint. The fewness of parts and simplicity of application adds interest to this joint.

The bolts, of charcoal iron alloy, are tough and resistant to corrosion and the oval design and reinforcement in the gasket avoids "cold-flow" and adds toughness. The joint appears to be about as foolproof as possible to make it. A booklet *"The R.D.W. Ovalseal Mechanical Joint"* describes and illustrates this new joint. Address R. D. Wood Company, 400 Chestnut St., Philadelphia, Pa.

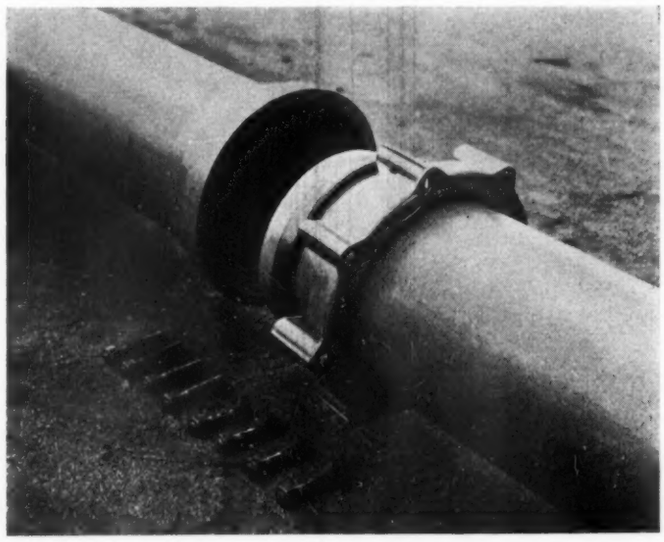
▼

Catalogs and Trade Literature Received

Cutler-Hammer Equipment: — "Successful Experiences in Water Works and Sewage Disposal Plants" is the title of a recent brochure which illustrates electrically operated valves, electrical control equipment, automatic motor and pump control devices manufactured by Cutler-Hammer for water works and sewerage systems. Ask for "Success Experiences." Address, Cutler-Hammer, Inc., Milwaukee, Wisc.

Blaw-Knox Gratings and Treads:—Electroforged Steel Gratings and Stop Treads, manufactured by Blaw-Knox Company of Pittsburgh, are described and illustrated in an attractive catalog of 16 pages, which lists advantages, given specifications, and pictures many typical installations, including some at water and sewage plants. Ask for catalog 1333A. —Blaw-Knox Co., Pittsburgh, Pa.

Nichols Herreshoff Incinerators:—Nichols Engineering Corporation, in a new bulletin illustrates and describes the design and operation of the multiple hearth Herreshoff furnace adapted to sewage sludge incineration. The recent installation at Dearborn, Mich., being the first at sewage treatment plants, has been sold on a guarantee basis to satisfactorily incinerate a chemical sludge. Ask for Bulletin 202—Nichols Engineering and Research Corp., 40 Wall St., New York City.



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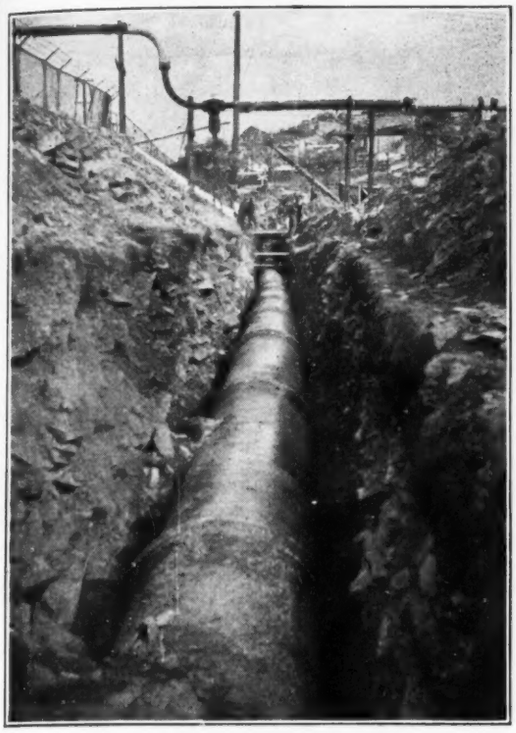

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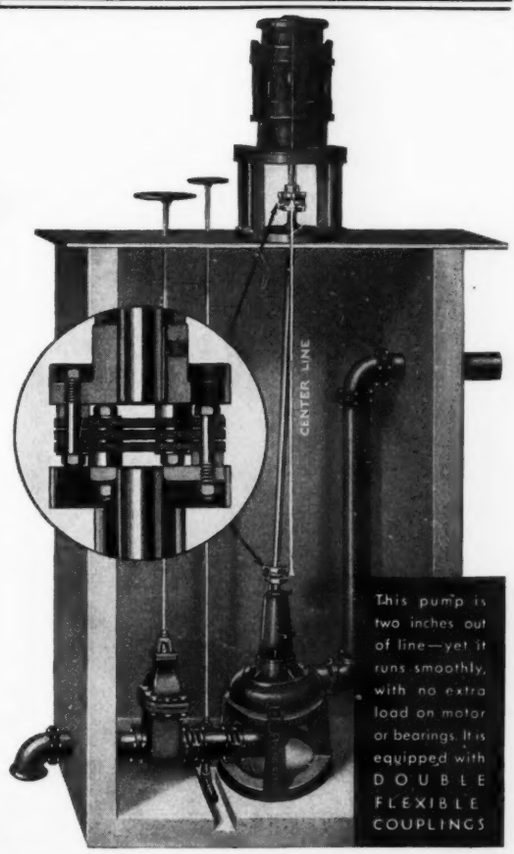
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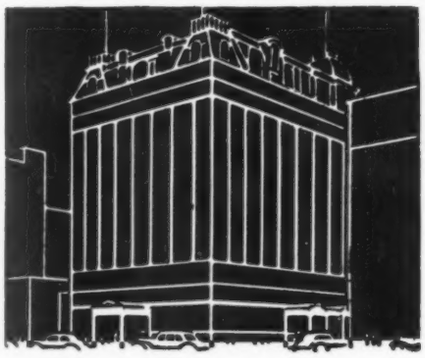

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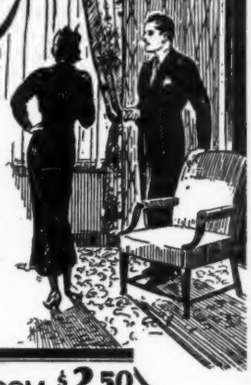

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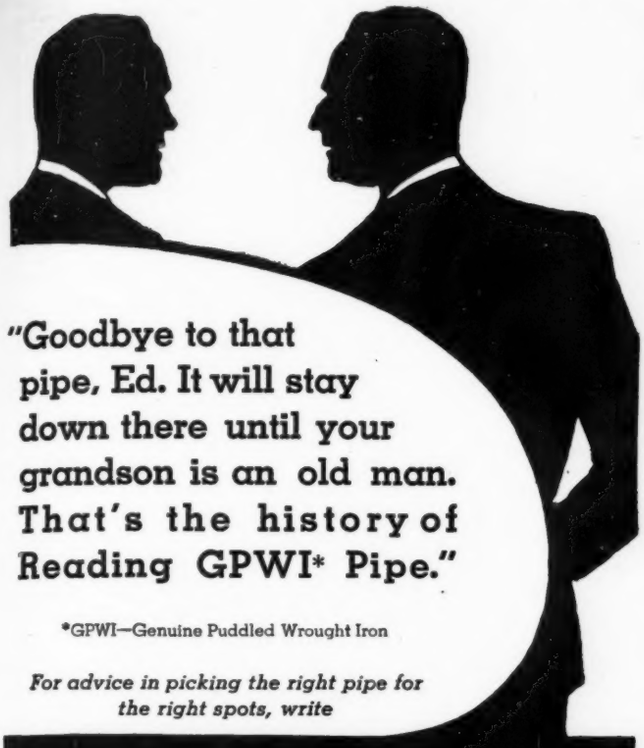

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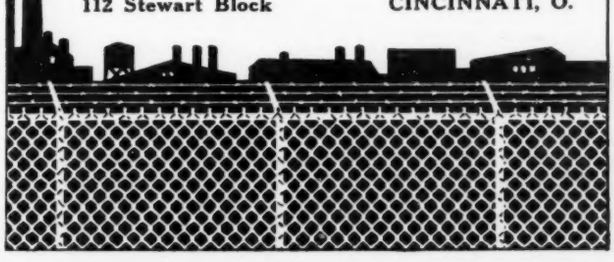

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POSITIONS WANTED

This department has been started as a service to those in the Water Works and Sewerage Fields. We hope they will make use of it. The notices are inserted without charge.

WATER WORKS MANAGER — Engineer with 13 years' experience in all phases of water works operation and management of utilities; has served as manager of private water company and since as Town Manager. Position with large Water Utilities Corporation preferred, but equipped to serve municipality as Superintendent or Manager. Address "E. H. R.," care of Water Works and Sewerage, 420 Lexington Ave., N. Y. C.

SANITATION ENGINEER—B. S. in Sanitary Engineering from recognized engineering school; 15 years in actual design and operation water supply and purification and sewerage and sewage treatment. Complete references on character, ability and competency furnished at request. Available on thirty days' notice. Address M. S. E., % Water Works and Sewerage, 420 Lexington Ave. New York City.

CONSTRUCTION ENGINEER—Has supervised the building of fifty miles of sewers and water works. Address A. W. K., Water Works and Sewerage, 400 W. Madison St., Chicago.

CHEMICAL ENGINEER—M.S., age 26, married, 2 years indust., 3 years prof. chem. engr., 1 year chem. and bactr. consultation, wants job, plant or laboratory work. Reasonable salary with opportunity for advancement. Six weeks' notice required. Address Box 600, % Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

CHEMIST, bacteriologist or operator of a sewage treatment or water purification plant. Four years' experience as chemist at the Southerly Sewage Treatment Works of Cleveland, O., and previous to that in the laboratories of the Baldwin Filtration Plant of same city. Can furnish excellent references. Graduate of Western Reserve University and just completed a year of graduate work at Ohio State University in Bacteriology and Chemistry. Address F. W. G., % Water Works & Sewerage, 400 W. Madison St., Chicago, Ill.

CIVIL ENGINEER—B. S. in Civil Engineering '34; age 24. Location immaterial. Desires work of any nature qualified for. Four years' experience previous to graduation—two years jr. draftsman in steel fabricating office, two years in N. Y. S. highway dep't. References. Available immediately. Address Andrew D. Korin, 709 W. Maumee St., Angola, Indiana.

JUNIOR CIVIL ENGINEER—B.S. in C.E. Age 27, married; one year of experience in Surveying and Drafting. Passed civil service examination for assistant sanitary engineer. Desires position in sanitary engineering field. Location immaterial. Available at once. M. P., Water Works and Sewerage, 400 W. Madison St., Chicago.

GRADUATE CIVIL ENGINEER—B.S. in Civil Engineering, Michigan College of Mining and Tech., '34. Specialized in Hydraulics. Enthusiastically interested in Sewage Disposal and Sewerage problems. Age 23, single. Employment under recognized authority preferred. Available immediately. Address L. P. M., Water Works and Sewerage, 400 W. Madison St., Chicago.

JUNIOR CIVIL ENGINEER — University graduate; single; age 26; seven months' drafting experience. Desires engineering position with civil or sanitary engineer, or with an engineering corporation. Salary and location open. Address "C. F. D.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

GRADUATE CIVIL ENGINEER. Univ. Michigan, 1932, specializing in Sanitary Engineering. Age 25. Experience as assistant in sanitary inspection of water supply, analysis sewage and sewage gas, determination source of odors in sewer system, gaging of sewers and streams. Now conducting independent research on sewage and garbage. For references and further information address G. W. H., % Water Works and Sewerage, 420 Lexington Ave., New York City.

SANITARY ENGINEER-CHEMIST—Graduate (C. E.), with 17 years' experience in design, construction, and operation of water purification plants and sewage treatment works. Experienced also in swimming pool sanitation and milk control. Can manage or superintend the operation of a water works or sewerage system. Address E. R., % Water Works and Sewerage, 420 Lexington Avenue, New York City.

SUPT. FILTRATION AND SEWAGE TREATMENT—Chemist with 10 years' experience in charge of water purification and sewage treatment works following experience in the industrial field. Also served as chemist with nationally known firm of Consulting Sanitary Engineers. Age 40, married. Desires immediate position with industrial plant engineering firm or municipality, without regard to location. A. B. C., % Water Works and Sewerage, 420 Lexington Ave., New York City.

POSITION WANTED—As superintendent filtration, chemist and bacteriologist, or operator chemist and bacteriologist. Of small or medium sized plant. By young man technically educated, careful, industrious and ambitious for plant betterment. Eleven years' experience. May I have the opportunity of communicating with you. Address J. Z. C., Water Works and Sewerage, 400 W. Madison St., Chicago.

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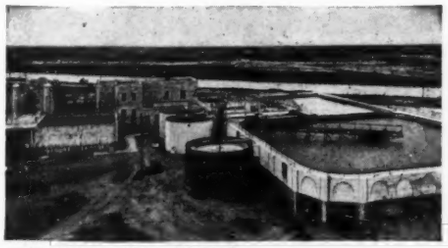

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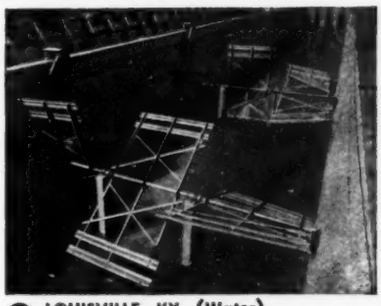

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